

**Course Structure and Syllabus  
of  
B.Tech Programme  
In  
ELECTRONICS & TELECOMMUNICATION  
ENGINEERING**



**(Admission Batch: 2018-19 Onwards)**

**INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG  
(An Autonomous Institute of Government of Odisha)  
Dhenkanal, Odisha- 759146  
[www.igitsarang.ac.in](http://www.igitsarang.ac.in)**

## INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

**Course Structure for 3<sup>rd</sup>Year B.Tech  
ELECTRONICS AND TELECOMMUNICATION ENGINEERING**

**(Admission Batch: 2018-19 Onwards)**

Fifth Semester				Sixth Semester			
Theory				Theory			
Course Code	Course Name	L-T-P (Periods/ Week)	Credits	Course Code	Course Name	L-T-P (Periods/ Week)	Credits
	<b>Programme Core Subject</b>			HSHM3306M/	Enhancing Soft Skills and	2-0-0	2
PCEC4306	Communication Engineering	3-0-0	3	HSHM3306	Personality		
PCEC4307	Digital Signal Processing	3-0-0	3		<b>Programme Core Subject</b>		
PCEC4308	VLSI Design	3-0-0	3	PCEC4309	Control System	3-0-0	3
(Any One)	<b>Programme Elective I</b> Refer the list of programme elective I	3-0-0	3	PCEC4310	Microwave Engineering	3-0-0	3
(Any One)	<b>Open Elective II</b> Refer List of Open Electives	3-0-0	3	(Any One)	<b>Programme Elective II</b> Refer the list of programme elective II	3-0-0	3
	<b>Mandatory Course V</b>	2-0-0	0	(Any One)	<b>Open Elective III</b> Refer List of Open Electives	3-0-0	3
MCGN9305/ MCHM9306	Environmental Science/ Universal Human Values				<b>Mandatory Course VI</b>	2-0-0	0
	<b>Total (Theory)</b>	<b>17</b>	<b>15</b>	MCHM9306/ MCGN9305	Universal Human Values/ Environmental Science		
	<b>Honours/ Minor</b>	3-1-0	4		<b>Total (Theory)</b>	<b>16</b>	<b>14</b>
HNEC0303	Machine Learning				<b>Honours/ Minor</b>	3-1-0	4
MNEC0303	Principles of Communication Engineering			HNEC0304	Cognitive Radio		
	<b>Practical/ Sessional</b>			MNEC0304	Computer Network and Data Communication		
PCEC7306	Communication Engineering Lab	0-0-3	2		<b>Practical/ Sessional</b>		
PCEC7307	Digital Signal Processing Lab	0-0-3	2	PCEC7309	Control and Instrumentation Lab	0-0-3	2
PCEC7308	VLSI Design Lab	0-0-3	2	PCEC7310	Microwave Engineering Lab	0-0-3	2
	<b>Total (Practical/ Sessional)</b>	<b>9</b>	<b>6</b>	HSHM3305	Business Communication & Interview Skills	0-0-3	1
	<b>TOTAL</b>	<b>26</b>	<b>21</b>	PJEC8301	Skill Project	0-0-3	2
					<b>Total (Practical/ Sessional)</b>	<b>12</b>	<b>7</b>
					<b>TOTAL</b>	<b>28</b>	<b>21</b>
TOTAL SEMESTER CREDITS: 21				TOTAL SEMESTER CREDITS: 21			
TOTAL CUMULATIVE CREDITS: 104				TOTAL CUMULATIVE CREDITS: 125			

**PROGRAMME ELECTIVE SUBJECTS**

<b>Programme Elective I List for 5<sup>th</sup> Semester</b>	
PEEC5301	Information Theory and Coding
PEEC5302	Fiber optics and Optoelectronic Devices
PEEC5303	Power Electronics
PEEC5304	Advanced Electronic Circuits
PEEC5305	Electrical & Electronics Measurements
PEEC5306	Materials Sciences for Electrical and Electronics Engineers

<b>Programme Elective II List for 6<sup>th</sup> Semester</b>	
PEEC5307	Computer Network and Data Communication
PEEC5308	Electrical Machine and Power Devices
PEEC5309	Mechatronics

**OPEN ELECTIVE SUBJECTS****OPEN ELECTIVE-II (OE-II) 5<sup>th</sup> Semester**

Sl. No.	Subject Code	Subject Name	Contact Hours	Credits	Departments to Teach the Subject	Students to whom Option is Open
1	OECH6311	Petroleum Refinery Engineering	3-0-0	3	Chemical Engg.	All branches
2	OECH6330	Green Technology	3-0-0	3	Chemical Engg, Civil Engg.	All branches
3	OECE6312	Mechanics of Solids	3-0-0	3	Civil Engg.	All branches
4	OECS6203	OOPs Using C++	3-0-0	3	CSE	CH, CS, EC, MM, PD
5	OECS6331	Cloud Computing	3-0-0	3	CSE	All branches
6	OEEE6313	Digital Signal Processing	3-0-0	3	Electrical Engg.	All branches
7	OEEC6314	Industrial Automation with PLC and SCADA	3-0-0	3	ETC Engg.	All branches
8	OEME6316	Introduction to Composite Materials	3-0-0	3	Mech. Engg.	All branches
9	OEMT6315	Nanomaterials	3-0-0	3	MME	All branches
10	OEPD6317	Powder Metallurgy	3-0-0	3	Prod. Engg.	All branches
11	OEMA6207	Numerical Methods	3-0-0	3	Mathematics	CE, EE, ME

**OPEN ELECTIVE-III (OE-III) 6<sup>th</sup> Semester**

Sl. No.	Subject Code	Subject Name	Contact Hours	Credits	Departments to Teach the Subject	Students to whom Option is Open
1	OECH6318	Food Biotechnology	3-0-0	3	Chemical Engg.	All branches
2	OECH6319	Fluidization Engineering	3-0-0	3	Chemical Engg.	All branches
3	OECE6320	Structural Dynamics and Earthquake Engineering	3-0-0	3	Civil Engg.	All branches
4	OECS6321	Data Science	3-0-0	3	CSE	All branches
5	OEEE6322	Sensors and Transducers	3-0-0	3	Electrical Engg.	All branches
6	OEEC6324	Mechatronics	3-0-0	3	ETC Engg.	All branches
7	OEHM6325	Marketing Management	3-0-0	3	Humanities	All branches
8	OEMA6326	Optimization in Engineering	3-0-0	3	Mathematics	All branches
9	OEME6327	Industrial Engineering and Operation Research	3-0-0	3	Mechanical Engg.	All branches
10	OEMT6328	Biomaterials	3-0-0	3	MME	All branches
11	OEPD6329	Operation Research	3-0-0	3	Prod. Engg.	All branches

CE: Civil Engineering

EE: Electrical Engineering

ME: Mechanical Engineering

CH: Chemical Engineering

HM: Humanities

CS, CSE: Computer Science and Engineering

EC, ETC: Electronics and Telecommunication Engineering

MT, MME: Metallurgical and Materials Engineering

PD, Prod.: Production Engineering

MA: Mathematics

**INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG**  
**B.TECH SYLLABUS for ELECTRONICS AND TELECOMMUNICATION ENGINEERING**  
 (Admission Batch: 2018-19 Onwards)  
 5<sup>th</sup> Semester

<b>PCEC4306</b>	<b>Communication Engineering</b>	<b>3-0-0</b>	<b>Credits 3</b>
-----------------	----------------------------------	--------------	------------------

**COURSE OBJECTIVES**

1. To know the need of modulation, modulation processes, and different amplitude modulation schemes
2. To analyze different angle modulation schemes with different generation and detection methods.
3. To know the types of noise and noise parameters
4. To know the generation and detection of pulse modulation techniques
5. To learn about theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods

**MODULE-I****(12 Hours)****Unit 1**

Overview of electronic communication system, signals and spectra, Fourier Transform of Signals, Orthogonal representation of signals.

**Unit 2**

Modulation schemes, Need for modulation, Amplitude Modulation (AM), Double side band suppressed carrier (DSB-SC) modulation, Hilbert transform, properties of Hilbert transform. In-phase and Quadrature component representation of band pass signals. Single side band (SSB) modulation and Vestigial-sideband (VSB) modulation.

**MODULE-II****(12 Hours)****Unit 3**

Angle modulation schemes: Frequency Modulation (FM) and Phase modulation (PM). Types of FM modulation: Narrow band FM and wide band FM. FM spectrum in terms of Bessel functions.

**Unit 4**

Direct and indirect (Armstrong's) methods of FM generation. Balanced discriminator, Foster-Seeley discriminator. Zero crossing detector and Ratio detector for FM demodulation. Phase demodulation.

**MODULE-III****(12 Hours)****Unit 5**

Noise Sources and types. Atmospheric noise, Shot noise and thermal noise. Noise temperature. Noise in two-port network: noise figure, equivalent noise temperature and noise bandwidth.

**Unit 6**

Noise figure and equivalent noise temperature of cascade stages. Narrow band noise representation. S/N ratio and Figure of merit calculations in AM, DSB-SC, SSB and FM systems, Pre-Emphasis and De-Emphasis.

**MODULE-IV****(8 Hours)****Unit 7**

Digital Carrier Modulation Schemes — Description and generation of ASK, FSK, PSK. Optimum receiver – matched filter, correlation receiver. Gaussian error probability -Coherent detection of Binary ASK, FSK, PSK, DPSK. Comparison of digital carrier modulation schemes. M-ary signaling schemes – Introduction, QPSK, Synchronization methods.

**Text Books:**

1. B.P. Lathi and Z. Ding, “Modern Digital and Analog Communication Systems,” 4th Ed., Oxford University Press, 2009.

**Reference Books:**

1. Simon Haykins John Wiley & Son “Analog and Digital Communication”, 4<sup>th</sup> edition, 2006.
2. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education, 2007.
3. B.Sklar, “Digital Communication Fundamentals and Applications”, 2nd Edition Pearson Education 2007.

**Course Outcomes:**

1. Distinguish between different amplitude modulation schemes with their advantages, disadvantages, and applications.
2. Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes.
3. Understand digital communication system and how noise affects communication.

<b>PCEC4307</b>	<b>Digital Signal Processing</b>	<b>3-0-0</b>	<b>Credits 3</b>
<b>COURSE OBJECTIVES</b>			
<ol style="list-style-type: none"> <li>1. To be familiar with the methods in DSP including digital filter design, and working of Signal Processors.</li> <li>2. To understand the transform domain processing and properties of different systems.</li> </ol>			

**MODULE – I****(12 Hours)****Unit-1****The Z-Transform and Its Application to the Analysis of LTI Systems**

The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; Analysis of Linear Time-Invariant Systems in the z-Domain: Response of Systems with rational System Functions.

**Unit-2****The Discrete Fourier Transform: Its Properties and Applications**

Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, Filtering of Long Data Sequences, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

**MODULE – II****(12 Hours)****Unit-3**

**Implementation of Discrete-Time Systems:** Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

**Unit-4**

**Design of Digital Filters:** General Considerations: Causality and Its Implications, Characteristics of Practical Frequency-Selective Filters; Design of FIR Filters: Symmetric and Anti-symmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

**MODULE- III****(12 Hours)****Unit-5**

**Efficient Computation of the DFT:** Fast Fourier Transform Algorithm Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT.

**Unit-6**

Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence.

**MODULE – IV****(8 Hours)****Unit 7**

**Adaptive Filters:** Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm, Minimum Mean Square Error Criterion.

**Text Books:**

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", 4<sup>th</sup> edition, Pearson, 2014.

**Reference Books:**

1. Sanjit K. Mitra, "Digital Signal Processing: a Computer-Based Approach", Tata McGraw Hill, 2012.
2. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2014.

**Course Outcomes:**

1. Thorough understanding of frequency domain analysis of discrete time signals.
2. Ability to design & analyze DSP systems like FIR, IIR, and adaptive filter, etc.
3. Get knowledge of practical implementation issues such as computational complexity, hardware of DSP systems or DSP processors.
4. Understanding of spectral analysis of the signals.

PCEC4308	VLSI Design	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To provide the basic understanding of layer information in the fabrication of MOSFET.</li> <li>2. To study the layout used by the manufacturer to design the IC.</li> <li>3. To know the scaling techniques used for the better optimization of the various design parameters required for the circuit design.</li> <li>4. To understand the static and switching characteristics of inverter circuits.</li> <li>5. To know the various types of faults involved in an IC.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b></p> <p><b>Introduction:</b> Historical Perspective, Concept of Feature Size in Integrated Circuit, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, Semi-Custom and Full-Custom Design Styles.</p> <p><b>Fabrication of MOSFETs:</b> Basic steps of Fabrication process, n-channel MOSFET fabrication, CMOS fabrication using n-Well Process, Schematic Diagram, Stick Diagram, Layout Design Rules, Layout Design.</p> <p><b>Unit 2</b></p> <p><b>MOS Transistor:</b> The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, Gradual Channel Approximation, Channel Length Modulation, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.</p>			

**MODULE-II****(12 Hours)****Unit 3**

**MOS Inverter Static Characteristics:** Introduction, Concept of Critical Voltages of Inverter Circuits, Calculation of Critical voltages of Resistive-Load Inverters, Inverters with n-Type MOSFET Load and CMOS Inverter.

**MOS Inverters Switching Characteristics:**

Introduction, Cascaded Inverter Circuit, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Switching Power Dissipation of CMOS Inverters.

**Unit 4**

**Combinational MOS Logic Circuits:** Introduction, MOS Logic Circuits with Depletion-type NMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates, Pass Transistor Logic, Complementary Pass-Transistor Logic (CPL).

**MODULE III****(12 Hours)****Unit 5**

**Sequential MOS Logic Circuits:** Introduction, Behaviour of Bistable Elements, SRLatch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

**Unit 6**

**Dynamic Logic Circuits:** Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Logic (Precharge and Evaluate Concept), Domino CMOS Logic.

**MODULE IV****(8 Hours)****Unit 7**

**Design for Testability:** Introduction, Fault Types and Models, Ad-Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques, Current Monitoring IDDQ Test.

**Text Books:**

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill Publishing Company Limited, 3<sup>rd</sup> edition, 2003.

**Reference Books:**

1. K. Eshraghian and N. H. E. Weste, "Principles of CMOS VLSI Design-a Systems Perspective", Addison Wesley, 2<sup>nd</sup> edition, 1993.
2. Debaprasad Das, "VLSI Design", Oxford University Press, 2<sup>nd</sup> Edition, 2015.

**Course Outcomes:**

1. To design the layout of any digital circuits using the two design rules.
2. To compare the techniques involved in the fabrication of MOSFET.
3. To implement the different types of inverter for the design of digital circuits.
4. To analyze the fault types and fault models used to detect the faults in an IC.

PEEC5301	Information Theory & Coding	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. Explain entropy, mutual information and characteristics of various types of noisy communication channels.</li> <li>2. Discuss various source coding schemes.</li> <li>3. Discuss channel coding techniques for error-free transmission of message over a noisy communication channel.</li> </ol> <p><b>MODULE-I (12 Hours)</b></p> <p><b>Unit 1</b>  <b>Basic Concepts of Information Theory:</b> The concept of Amount of Information, Average Information, Entropy, Information rate, Mutual information; Shannon's Theorem.</p> <p><b>Unit 2</b>  Channel capacity; BSC and other channels, Capacity of a Gaussian Channel, Bandwidth – S/N Tradeoff; Introduction to Channel Capacity &amp; Coding; Channel Models, Channel Capacity Theorem, Shannon Limit.</p> <p><b>MODULE-II (12 Hours)</b></p> <p><b>Unit 3</b>  <b>Introduction to Error Control Coding:</b> Linear Block Codes- Introduction to Linear Block codes, Syndrome and Error detection, Minimum distance of block code, Hamming Code.</p> <p><b>Unit 4</b>  <b>Cyclic Codes:</b> Description of Cyclic codes, Generator and parity check matrices of cyclic codes, error detection decoding of cyclic codes.  <b>BCH Codes:</b> Description of codes; Decoding of BCH codes; Implementation of error connection.</p> <p><b>MODULE-III (12 Hours)</b></p> <p><b>Unit 5</b>  <b>Convolution Codes:</b> Encoding of convolution codes; structural properties of Convolution codes; Distance Properties of convolution codes.</p> <p><b>Unit 6</b>  Automatic Repeat Request Strategies- Stop and wait, Go back and selective repeat ARQ strategies, Hybrid ARQ Schemes.</p> <p><b>MODULE-IV (8 Hours)</b></p> <p><b>Unit 7</b>  <b>Discrete Messages and information content:</b> The Concept of amount of Information, Average Information, Entropy; Information rate, Source coding to increase average information per bit; Shanon-Fano coding; Huffman source coding algorithm, Lempel Ziv source coding algorithm.</p>			

**Text Books:**

1. Digital Communications- Fundamental and applications, Bernard Sklar, Pearson Education Publication, 2<sup>nd</sup> Edition, 2009

**Reference Books:**

1. John Proakis, "Digital Communications", Tata McGraw Hill, 5th edition., 2008.
2. Simon Haykin, "Communication System", Wiley, 2008.
3. Jorge Castineira, Moreira, "Essentials of Error Control Coding", Wiley, 2006.

**Course Outcomes:**

1. Design the channel performance using the principles of Information theory.
2. Comprehend various error control code properties
3. Apply linear block codes for error detection and correction
4. Apply convolution codes for performance analysis & cyclic codes for error detection and correction.
5. Design BCH & RS codes for channel performance improvement against burst errors.

PEEC5302	Fiber Optics and Optoelectronic Devices	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To expose the students to the basics of signal propagation through optical fibers, fiber impairments, and components of optical systems.</li> <li>2. To recognize and classify the structures of optical fiber and types.</li> <li>3. To understand the working principle of various optical sources and detectors.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b></p> <p><b>Optical Fibers: Structures and Fabrication:</b> Basic optical laws, Optical fiber modes and configurations, Mode theory of optical waveguides, single mode fibers, Graded indexed fibers, Photonic crystal fibers, Fiber materials, Fiber fabrication, Mechanical properties of fiber, fiber optics cables, grating theory, application of diffraction grating, electro-optic effect.</p> <p><b>Unit 2</b></p> <p><b>Transmission Characteristics of Optical Fibers:</b> Attenuation, Material absorption losses, Linear and Nonlinear scattering losses, Chromatic Dispersion and Intermodal Dispersion.</p> <p><b>MODULE-II</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 3</b></p> <p><b>Opto-Electronic Sources:</b> Light Emitting Diodes: Structure, LED power and Efficiency, Characteristics, Modulation, response times of LEDs.</p>			

**Unit 4**

Laser diodes: Structure, Working Principle, Population Inversion, Efficiency, lasers classifications, lasers applications.

**MODULE-III****(12 Hours)****Unit 5**

**Photo Detectors:** Optical detection Principles, Absorption, Quantum Efficiency, Responsivity, PN photo diode, PIN photo diode, Speed of response and traveling-wave photodiodes, Photo detector noise, SNR calculation.

**Unit 6**

**Optical Fiber Sensors:** Active and passive optical fiber sensor, intensity modulated sensor, displacement type sensors, multimode active optical fiber sensor (micro bend sensor) and polarization sensors.

**MODULE-IV****(8 Hours)****Unit 7**

**Optical Amplifiers and Optical Components:** Introduction to optical amplifiers, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers, amplifier noise, optical SNR, wideband optical amplifiers, Overview of WDM, passive optical couplers, Isolators and circulators, fiber grating filters, Diffraction gratings, Active optical components.

**Text Books:**

1. John M. Senior, "Optical Fiber Communication Principles and practice," Pearson Prentice Hall Education, 3<sup>rd</sup> Edition, 2015.

**Reference Books:**

1. J. M. Senior, "Optical Fiber Communication-Principles and Practice", Prentice Hall of India, 1<sup>st</sup> edition, 1985.
2. G. Keiser, "Optical Fiber Communications", Tata McGraw Hill Education Private Limited, 5<sup>th</sup> edition, 2014.
3. G. P. Agrawal, "Fiber Optic Communication Systems", Wiley, 3<sup>rd</sup> edition, 2002.

**Course Outcomes:**

1. Understand the concept and working of fiber optics and different optoelectronic devices.
2. Provide adequate knowledge about the Industrial applications of optical fibers.
3. Discuss the channel impairments like losses and dispersion.

PEEC5303	Power Electronics	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>To understand and acquire knowledge about various power semiconductor devices.</li> <li>To prepare the students to analyze and design different power converter circuits.</li> </ol> <p><b>MODULE-I ( 12 Hours)</b></p> <p><b>Unit 1</b>  <b>Power electronics devices:</b> Characteristics of power devices – characteristics of SCR, diac, triac, SCS, GTO, PUJT, power transistors – power FETs – LASCR – two transistor model of SCR – Protection of thyristors against over voltage – over current, dv/dt and di/dt.</p> <p><b>Unit 2</b>  <b>Triggering techniques:</b> Turn on circuits for SCR – triggering with single pulse and train of pulses synchronizing with supply – triggering with microprocessor – forced commutation – different techniques – series and parallel operations of SCRs.</p> <p><b>MODULE-II (12 Hours)</b></p> <p><b>Unit 3</b>  <b>Controlled rectifiers:</b> Converters – single phase – three phase – half controlled and fully controlled rectifiers – Waveforms of load voltage and line current under constant load current.</p> <p><b>Unit 4</b>            Effect of transformer leakage inductance – dual converter</p> <p><b>MODULE-III (12 Hours)</b></p> <p><b>Unit 5</b>  <b>Inverters:</b> Voltage and current source inverters, resonant, Series inverter, PWM inverter. AC and DC choppers – DC to DC converters – Buck, boost and buck – boost.</p> <p><b>Unit 6</b>  <b>Cyclo-converters:</b> Principle of cyclo converter operation, step up and step down cyclo converters, Three phase half wave converters, Output voltage equation for a cyclo converter, Load commutated cyclo converter.</p> <p><b>MODULE-IV (8 Hours)</b></p> <p><b>Unit 7</b>  <b>Industrial applications DC motor drives</b> – Induction and synchronous motor drives – switched reluctance and brushless motor drives.  <b>Battery charger</b> – SMPS – UPS – induction and dielectric heating.</p> <p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Muhammad H. Rashid, “Power Electronics Circuits, Devices and Applications”, Prentice Hall India, 3<sup>rd</sup> Edition. 2004.</li> </ol>			

**Reference Books:**

1. P S Bimbhra, "Power Electronics", Khanna Publishers, 5<sup>th</sup> Edition, 2012.
2. P C Sen, "Power Electronics", Tata McGraw Hill, 1987.

**Course Outcomes:**

1. Acquire knowledge about fundamental concepts and techniques used in power electronics.
2. Ability to analyze various single phase and three phase power converter circuits and understand their applications.
3. Foster ability to identify basic requirements for power electronics based design application.
4. To develop skills to build, and troubleshoot power electronics circuits.
5. Foster ability to understand the use of power converters in commercial and industrial applications.

PEEC5304	Advanced Electronics Circuits	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To build capability in students to design advanced electronics circuits for different applications.</li> <li>2. To introduce various advanced analog electronics circuits.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b></p> <p><b>Active Filters:</b> Active Filters, Frequency response of Major Active filters, First order low-pass Butterworth filter: Filter Design, Frequency Scaling, Second-order low pass Butterworth filter: First-order high-pass Butterworth filter, Second-order high pass Butterworth filter, Band-pass filters: Wide band-pass Filter, Narrow Band-Pass Filter, Band-reject filters: Wide Band-Reject Filter, Narrow Band-Reject Filter, All Pass filter.</p> <p><b>Unit 2</b></p> <p><b>Oscillators:</b> Oscillator Principles, Oscillator Types, Quadrature Oscillator, Saw tooth wave generator, Voltage-controlled oscillator.</p> <p><b>Comparators:</b> Comparators: basic comparator, zero-crossing detector, Schmitt trigger, comparator characteristics, limitations of Op-Amp as comparators, voltage limiters.</p> <p><b>MODULE-II</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 3</b></p> <p><b>Bistable Multivibrator:</b> Bistable Multivibrator, fixed-bias bistable multi vibrator, Loading, self-biased transistor binary, commutating capacitors, Triggering the binary, Unsymmetrical Triggering of the bistable multivibrator, Triggering Unsymmetrically through a Unilateral Device, Triggering of a Bistable Multi Symmetrically without the Use of Auxiliary Symmetrical Diodes, Schmitt Trigger Circuit (Emitter-coupled Bistable Multivibrator).</p>			

**Monostable and Astable Multivibrator:** Monostable Multivibrator, Gate Width of a Collector-Coupled Monostable Multivibrator, Waveforms of the Collector-Coupled Monostable Multivibrator, Emitter-Coupled Monostable Multivibrator, Triggering of the Monostable Multivibrator, Astable Collector-Coupled Multivibrator, Emitter coupled Astable multivibrator.

#### Unit 4

**Wideband amplifiers:** Wideband amplifiers: The Hybrid- $\pi$ , High-frequency, Small signal, Common-emitter Model, RC-Coupled Amplifier, Frequency Response of a Transistor Stage-The Short-Circuit Current Gain, Current Gain with Resistive Load, Transistor Amplifier Response taking Source Impedance into Account, Transient Response of a Transistor Stage.

### MODULE-III

(12 Hours)

#### Unit 5

**Negative Resistance Switching Devices:** Voltage Controllable Negative resistance devices, Tunnel Diode operation and characteristics, Monostable, Astable, Bistable circuits using tunnel diode, Voltage controlled Negative Resistance Switching Circuits.

#### Unit 6

**Voltage and Current Time Base Generators:** Time-Base Generators, General features of a Time-base signal, Methods of generating a voltage time-base waveform, Exponential sweep circuit, Miller and bootstrap time base generators-Basic principles, Transistor miller time base generator, Transistor bootstrap time base generator, Current Time-Base Generators, A Simple Current sweep, Linearity Correction through adjustment of driving waveform, Transistor current time base generator.

### MODULE-IV

(8 Hours)

#### Unit 7

**Specialized IC Applications:** IC 555 Timer: IC 555 Timer as a Monostable Multivibrator and its applications, IC 555 Timer as Astable Multivibrator and its applications. Phase Locked Loop: Operating principle of PLL, Phase detectors, Exclusive-OR phase detector, Monolithic phase detector, Instrumentation Amplifier and its applications.

#### Text Books:

1. Jacob Millman, Herbert Taub and M.S. Prakash Rao, "Pulse Digital and switching Waveforms" , TMH Publication, Second Edition, 2007

#### Reference Books:

1. David A. Bell, "Pulse Switching and Digital Circuits", Oxford University Press, Fifth Edition, 215.
2. Ramakant A. Gayakwad, "OP-Amps and Linear Integrated Circuits", Prentice Hall India Publication, 2002.

#### Course Outcomes:

1. To analyze different types of advanced electronics circuits.
2. To design advanced analog electronic circuits for different applications

PEEC5305	Electrical and Electronics Measurements	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>To understand the concept of different types of errors and standards of measurement.</li> <li>To measure resistance, inductance, capacitance by using of different types of electronics bridges.</li> <li>To study the construction and working of current transformer and potential transformer.</li> <li>To provide better understanding of various meters used for measurement.</li> </ol> <p><b>MODULE-I (12 Hours)</b></p> <p><b>Unit 1</b>  <b>Introduction:</b> Measurement and Error: Definition, Accuracy and Precision; Significant Figures, Types of Errors. Standards of Measurement: Classification of Standards, Electrical Standards, IEEE Standards.</p> <p><b>Unit 2</b>  <b>Measurement of Resistance:</b> Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance.</p> <p><b>MODULE-II (12 Hours)</b></p> <p><b>Unit 3</b>  <b>Measurement of Inductance:</b> Measurement of Self Inductance by Ammeter and Voltmeter, and AC Bridges (Maxwell's, Hay's, and Anderson Bridges).</p> <p><b>Unit 4</b>  <b>Measurement of Capacitance:</b> Measurement of Capacitance by Ammeter and Voltmeter, and AC Bridges (Owen's, Schering &amp; Wien's Bridge), Screening of Bridge Components and Wagner Earthing Device.</p> <p><b>MODULE-III (12 Hours)</b></p> <p><b>Unit 5</b>  <b>Galvanometer:</b> Construction, Theory and Principle of operation of D' Arsonval, Vibration (Moving Magnet &amp; Moving Coil types), and Ballistic Galvanometer.  <b>Ammeter and Voltmeter:</b> Derivation for Deflecting Torque of; PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction Type Ammeters and Voltmeters.</p> <p><b>Unit 6</b>  <b>Potentiometer:</b> Principle of operation of DC Potentiometers (Crompton, Vernier, Constant Resistance and Deflection Potentiometer); AC Potentiometers (Drysdale-Tinsley and Gall-Tinsley Potentiometer).</p> <p><b>MODULE-IV (8 Hours)</b></p> <p><b>Unit 7</b></p>			

**Measurement of Power, Energy, Frequency and Power factor:** Measurement of single phase and three phase power by wattmeter, Construction, Theory and Principle of operation of (a) Electro-Dynamometer and Induction type Watt meters, (b) Single Phase and Poly Phase Induction Type Watt-hour meters, (c) Frequency Meters, and (d) Power Factor Meters.

**Current Transformer and Potential Transformer:** Construction, Theory, Characteristics and Testing of CTs and PTs.

**Electronic Instruments for Measuring Basic Parameters:** Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Considerations for choosing an Analog Voltmeter, Digital Voltmeters (Block Diagrams only), Q-meter.

**Text Books:**

1. A K Sawhney, Puneet Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co, 2013.

**Reference Books:**

1. H C Kalsi, "Electronic Instrumentation", Tata McGraw Hill, 2nd edition, 2003
2. Joseph J. Carr, "Elements of Electronic Instrumentation and Measurement", Pearson Education, 3rd edition, 2003.
3. J.B. Gupta, "Electrical Measurement and Measuring Instrument", S.K. Kataria & Sons, 5th edition, 2015.
4. Albert D Helfrick & W. D Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 2nd Edition Phi Learning, 2012.

**Course Outcomes:**

1. Understand operation of different instruments.
2. Learn different terminology related to measurements.
3. Understand the principles of various types of transducers and sensors.

<b>PEEC5306</b>	<b>Material Science for Electrical &amp; Electronics Engineers</b>	<b>3-0-0</b>	<b>Credits 3</b>
-----------------	--	--------------	------------------

**COURSE OBJECTIVES**

1. To give idea about dielectric and magnetic properties of materials.
2. To introduce materials property, application, advantage, disadvantages.

**MODULE-I**

**( 12 Hours)**

**Unit 1**

**Conductivity of Metal:** Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field

emission.

### Unit 2

Effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects.

## MODULE-II

(12 Hours)

### Unit 3

**Dielectric Properties:** Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation.

### Unit 4

Frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferro-electricity, piezoelectricity.

## MODULE-III

(12 Hours)

### Unit 5

**Semiconductors:** Energy band in solids, conductors, semiconductors and insulators, types of semiconductors.

### Unit 6

Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

## MODULE-IV

(8 Hours)

### Unit 7

**Magnetic properties of Materials:** Introduction, Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

### Text Books:

1. C.S.Indulkar and S. Thiruvengadam, "An Introduction to Electrical Engineering", S. Chand & Co., 2008.

### Reference Books:

1. W.D. Callister, Jr., "Materials Science and Engineering, An Introduction" Wiley -- 7th Edition, 2012.
2. Kenneth G. Budinski, "Engineering Materials: Prentice Hall of India, New Delhi, 2009

### Course Outcomes:

1. To apply material science to solve engineering problems.
2. To select materials for design and construction.

**MANDATORY COURSE**

<b>MCGN9305</b>	<b>Environmental Science</b>	<b>2-0-0</b>	<b>Credit-0</b>
<p><b>Unit 1: Multidisciplinary nature of environmental studies</b>            Definition, scope and importance), Need for public awareness.</p> <p><b>Renewable and non-renewable resources</b>            Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.</p> <p><b>Unit 2: Ecosystems</b>            Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems:-</p> <ol style="list-style-type: none"> <li>Forest ecosystem</li> <li>Grassland ecosystem</li> <li>Desert ecosystem</li> <li>Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)</li> </ol> <p><b>Unit 3: Biodiversity and its conservation</b></p> <ul style="list-style-type: none"> <li>• Introduction – Definition: genetic, species and ecosystem diversity.</li> <li>• Bio geographical classification of India</li> <li>• Biodiversity at global, National and local levels.</li> <li>• India as a mega-diversity nation</li> <li>• Hot-spots of biodiversity.</li> <li>• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.</li> <li>• Endangered and endemic species of India</li> <li>• Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.</li> </ul> <p><b>Unit 4: Environmental Pollution</b> Cause, effects and control measures of :-            Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.</p> <p><b>Unit 5: Social Issues and the Environment</b>            Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.</p> <p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India.</li> </ol>			

2. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication.
3. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India.

## MANDATORY COURSE

<b>MCHM9306</b>	<b>Universal Human Values</b>	<b>2-0-0</b>	<b>Credit-0</b>
<b>Objective:</b>			
<ol style="list-style-type: none"> <li>1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education.</li> <li>2. To sensitize the student towards issues in society and nature.</li> <li>3. To Strengthen self-reflection to know what the students ‘really want to be’ in their life and profession.</li> <li>4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life.</li> </ol>			
<b>Module I</b>		<b>10 Hours</b>	
<ol style="list-style-type: none"> <li>1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process;</li> <li>2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations.</li> <li>3. Method to fulfill the human aspirations: understanding and living in harmony at various levels.</li> </ol>			
<b>Module II</b>		<b>10 Hours</b>	
<ol style="list-style-type: none"> <li>1. Human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Self (‘I’) and ‘Body’ - <i>Sukh</i> and <i>Suvidha</i></li> <li>2. Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), the characteristics and activities of ‘I’ and harmony in ‘I’,</li> <li>3. Harmony of I with the Body: <i>Sanyam</i> and <i>Swasthya</i>; Needs of Body and Psyche: <i>Sanyam</i> and <i>Swasthya</i></li> </ol>			
<b>Module III</b>		<b>12 Hours</b>	
<ol style="list-style-type: none"> <li>1. Harmony in the Family, values in human-human relationship; Trust (<i>Vishwas</i>) and Respect (<i>Samman</i>) as the foundational values of relationship, meaning of <i>Vishwas</i> and <i>Samman</i></li> <li>2. Harmony in the society: <i>Samadhan</i>, <i>Samridhi</i>, <i>Abhay</i>, <i>Sah-astitva</i>, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature</li> </ol>			

3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education,

**Module IV****08 Hours**

1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management
2. Strategy for transition from the present state to Universal Human Order
3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

**Text Book:**

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

**References Books:**

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

**Course Outcome:**

On completion of this course, the students will be able to:

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

**HONOURS**

<b>HNEC0303</b>	<b>Machine Learning</b>	<b>3-1-0</b>	<b>Credits 4</b>
-----------------	-------------------------	--------------	------------------

**COURSE OBJECTIVES**

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To develop skills of using recent machine learning software for solving problems.

**MODULE-I****( 12 Hours)****Unit 1**

**Introduction:** History of Machine Learning, Programs vs learning algorithms, Machine Learning definition, Components of a learning, Different Types of Learning

**Unit 2**

Concept Learning Task, Concept learning as search, Inductive Learning Bias, FIND-S and Candidate-Elimination algorithm.

**MODULE-II****(12 Hours)****Unit 3**

Decision Trees, Basic decision trees learning algorithm, inductive bias in decision tree learning, over fitting Artificial Neural Networks, Perceptron, Multilayer networks and Back-propagation algorithm

**Unit 4**

Introduction to Deep Neural networks, Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs), Evaluating Hypotheses, Basics of sampling theory, comparing learning algorithms

**MODULE-III****(12 Hours)****Unit 5**

Bayesian learning and Bayesian networks, Gibbs algorithm, EM algorithm, Naive Bayes classifier, Instance based learning, K-Nearest-Neighbor.

**Unit 6**

Locally weighted linear Regression, Logistic Regression, SVM, Multiclass & Ordinal Classification , Kernel Methods

**MODULE-IV****(12 Hours)****Unit 7**

Clustering, Generative Models, Mixture Models , Hidden Markov Model, Genetic Algorithms, Introduction to Analytical Learning, Combining Inductive and Analytical learning, Reinforcement learning, adaptive hierarchical clustering, Gaussian mixture model.

**Text Books:**

1. Chris Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

**Reference Books:**

1. Mitchell Tom, "Machine Learning", McGraw Hill, 1997.
2. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall India, 2004.
3. Course material available on Swayam platform and NPTEL, for the course on Introduction to

Machine Learning, conducted by Prof. Sudeshna Sarkar, IIT Kharagpur.

**Course Outcomes:**

1. Recognize the characteristics of machine learning that make it useful to real-world problems.
2. Characterize machine learning algorithms as supervised, semi-supervised, and unsupervised.
3. Effectively use machine learning toolboxes.
4. Be able to use support vector machines.
5. Be able to use regularized regression algorithms.
6. Understand the concept behind neural networks for learning non-linear functions.
7. Understand and apply unsupervised algorithms for clustering.
8. Understand the foundation of generative models.
9. Understand the inference and learning algorithms for the hidden Markov model.
10. Understand the learning algorithm for hidden Markov model with latent variables.

**MINOR**

<b>MNEC0303</b>	<b>Principles of Communication Engineering</b>	<b>3-1-0</b>	<b>Credits 4</b>
-----------------	--	--------------	------------------

**COURSE OBJECTIVES**

1. To introduce students to various modulation and demodulation techniques of analog and digital communication.
2. To introduce the concept of noise in communication system.
3. To introduce the concept of multiple access techniques.

**MODULE-I (12 Hours)**

**Unit 1**

**Analog Communication:** Introduction to communication system, Need of modulation, generation of AM, DSB, DSB/SC, SSB, VSB AM Transmitter & Receiver, Demodulation of AM.

**Unit 2**

FM and PM – frequency spectrum – power relations: NBFM & WBFM, Generation of FM and PM, Demodulations of FM and PM.

**MODULE-II**

**(12 Hours)**

**Unit 3**

**Noise in Amplitude Modulation:** Noise in Amplitude Modulation: Analysis, Signal to Noise Ratio, Figure of Merit.

**Unit 4**

**Noise in Frequency Modulation:** Pre-emphasis, De-Emphasis and SNR Improvement, Phase Locked Loops

Analog and Digital.

**MODULE-III****(12 Hours)****Unit 5**

**Digital Communication:** Concepts of sampling and sampling theorems, PAM, PWM, PPM, PTM.

**Unit 6**

Quantization and coding: DCM, DM, slope overload error. ADM, DPCM, OOK systems – ASK, FSK, PSK, BSK, QPSK, QAM, MSK, GMSK, applications of Data communication.

**MODULE-IV****(12 Hours)****Unit 7**

**Multiple Access Technique:** Introduction to multiple access techniques, FDMA, TDMA, CDMA, SDMA. Applications of multiple access techniques in wireless Communication. Advantages and disadvantages.

**Text Books:**

1. B.P Lathi, “Modern Digital and Analog Communication Systems”, Oxford University press, 3<sup>rd</sup> Edition, 2007

**Reference Books:**

1. Simon Haykins, “Communication Systems” John Wiley & Sons, 4<sup>th</sup> Edition, 2005.
2. H. Taub, D L Schilling and G Saha, “Principles of Communication Systems”, Tata Mc Graw Hill Education, 4th Edition ,2013
3. Leon W. Couch-II, “Digital and Analog Communication System”, Pearson Education, 6<sup>th</sup> Edition 2001.

**Course Outcomes:**

1. The student will be able to compare the performance of AM, FM, and PM with reference to SNR.
2. Understand different digital modulation techniques and different multiple access techniques.

**PRACTICAL / SESSIONAL**

<b>PCEC7306</b>	<b>Communication Engineering Lab</b>	<b>0-0-3</b>	<b>Credits 2</b>
<p><b>LIST OF EXPERIMENTS:</b></p> <ol style="list-style-type: none"> <li>1. Signal Sampling and reconstruction</li> <li>2. Time Division Multiplexing.</li> <li>3. AM Modulator and Demodulator.</li> <li>4. FM Modulator and Demodulator.</li> <li>5. Pulse Code Modulation and Demodulation.</li> <li>6. Delta Modulation and Demodulation.</li> <li>7. FSK, PSK and DPSK schemes (Simulation).</li> <li>8. Observation (simulation) of signal constellations of BPSK, QPSK and QAM.</li> <li>9. Line coding schemes.</li> <li>10. Error control coding schemes - Linear Block Codes (Simulation)</li> </ol>			

<b>PCEC7307</b>	<b>Digital Signal Processing Lab</b>	<b>0-0-3</b>	<b>Credits 2</b>
<p><b>Experiment List:</b></p> <ol style="list-style-type: none"> <li>1. Familiarization with the architecture of a standard DSP kit (Preferably TMS 320C6XXX DSP kit of Texas Instruments)</li> <li>2. Generation of various types of waveforms (sine, cosine, square, triangular etc.) using MATLAB and DSP kit.</li> <li>3. Linear convolution of sequences (without using the inbuilt conv. function in MATLAB) and verification of linear convolution using DSP kit.</li> <li>4. Circular convolution of two sequences and comparison of the result with the result obtained from linear convolution using MATLAB and DSP kit.</li> <li>5. (i) Computation of autocorrelation of a sequence, cross correlation of two sequences using MATLAB. (ii) Computation of the power spectral density of a sequence using MATLAB also implementing the same in a DSP kit.</li> <li>6. Finding the convolution of a periodic sequence using DFT and IDFT in MATLAB.</li> </ol>			

7. (i) Implementation of FFT algorithm by decimation in time and decimation in frequency using MATLAB. (ii) Finding the FFT of a given 1-D signal using DSP kit and plotting the same.
8. Design and implementation of FIR (lowpass and highpass) Filters using windowing techniques (rectangular window, triangular window and Kaiser window) in MATLAB and DSP kit.
9. Design and implementation of IIR (lowpass and highpass) Filters (Butterworth and Chebyshev) in MATLAB and DSP kit.
10. (i) Convolution of long duration sequences using overlap add, overlap save using MATLAB.  
(ii) Implementation of noise cancellation using adaptive filters on a DSP kit.

PCEC7308	VLSI Design Lab	0-0-3	Credits 2
<p><b>Experiment List:</b></p> <ol style="list-style-type: none"> <li>1. Design &amp; implementation of 64-bit Arithmetic &amp; Logic unit of a processor using VHDL.</li> <li>2. Design &amp; implementation of data security unit using VHDL.</li> <li>3. Design &amp; implementation of 16-bit parallel adder using VHDL.</li> <li>4. Modeling and transient analysis of CMOS inverter using p-SPICE.</li> <li>5. Modeling and transient analysis of CMOS based 2-inputs NOR gate using p-SPICE.</li> <li>6. Modeling and transient analysis of CMOS based 2-inputs NAND gate using p-SPICE.</li> <li>7. Plotting of VTC curve of CMOS inverter using p-SPICE.</li> <li>8. Design of schematic and simple layout of CMOS Inverter with its simulation.</li> <li>9. Design of schematic and simple layout of CMOS based NAND gate with its simulation.</li> <li>10. Design of schematic and simple layout of CMOS based NOR gate with its simulation.</li> </ol>			

**OPEN ELECTIVE-II (OE-II) 5<sup>th</sup> Semester**

<b>OECH6311</b>	<b>Petroleum Refinery Engineering</b>	<b>3L-0T-0P</b>	<b>3 Credits</b>
<p><b>Course objectives:</b> The objectives of this course are</p> <ol style="list-style-type: none"> <li>1. Indicate what crude oils consists of and how crude oils are characterized based on their physical properties.</li> <li>2. Demonstrate how a petroleum refinery works and sketch a flow diagram that integrates all refining processes and the resulting refinery products.</li> <li>3. Examine how each refinery process works and how physical and chemical principles are applied to achieve the objectives of each refinery process.</li> </ol>			
<p><b>Module-1</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Overview of Petroleum Refinery its Products and Properties</b></p> <p><b>Unit I (6 Hours/ 2 weeks):</b> Origin and formation of petroleum, reserves and deposits of the world, Indian petroleum industries, Composition and Compounds of Petroleum, Crude pre-treatment: Desalting and Dehydration, Petroleum Refinery Units.</p> <p><b>Unit II (6 Hours/ 2 weeks):</b> Properties of Crude oil, Test Methods for Gasoline and Diesel, Refinery Products: Gasoline and its Specification, Distillate Fuels, Residual Fuel Oils, LPG, ASTM and TBP Distillation, Octane and Cetane number.</p> <p><b>Module-2</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Refinery Processes Units</b></p> <p><b>Unit III (6 Hours/ 2 weeks):</b> Coking and Thermal Processes, Catalytic Cracking</p> <p><b>Unit IV (6 Hours/ 2 weeks):</b> Catalytic Hydrocracking, Hydro processing and Resid Processing.</p> <p><b>Module-3</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Refinery Processes Units</b></p> <p><b>Unit V (6 Hours/ 2 weeks):</b> Hydro treating, Catalytic Reforming and Isomerization</p> <p><b>Unit VI (6 Hours/ 2 weeks):</b> Alkylation and Polymerization, Visbreaking.</p>			

**Module-4****(2 weeks/6 Hours)****Treatment of Products**

**Unit VII (6 Hours/ 2 weeks):** Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.

**Text book :**

1. 'Petroleum Refining: Technology and Economics', 5th ed. by J H Gary, G E Handwerk, and M J Kaiser, CRC Press.

**Reference Books :**

1. 'Modern Petroleum Refining Processes', 6th ed. by B K B Rao, Oxford & IBH.
2. 'Petroleum Refinery Engineering', W L Nelson, McGraw-Hill.
3. 'Handbook of Petroleum Processing', 2<sup>nd</sup> ed. by S A Treese, P R Pujado and D S J Jones, Springer.

**Course Outcomes (CO):**

At the end of the course, students

1. Have introductory information about petroleum and refinery.
2. Learn the history of refinery development and composition of petroleum.
3. Learn refinery products, test methods and petroleum properties.
4. Should have knowledge about the different process units involved in refinery to get the valuable products like Gasoline, Diesel etc. that can be directly use by the consumers.

<b>OECH6330</b>	<b>GREEN TECHNOLOGY</b>	<b>3L-0T-0P</b>	<b>3 Credits</b>
<p><b>Objectives:</b></p> <ol style="list-style-type: none"> <li>1. To present different concepts of green technologies.</li> <li>2. To acquire principles of Energy efficient technologies.</li> <li>3. To learn the importance of green fuels and its impact on environment.</li> </ol>			
<p><b>Module-1</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>            Unit I: Principles of green technology and engineering.            Unit II: Principles of atom and mass economy, E-factor.</p> <p><b>Module-2</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>            Unit III: Design of greener and safer chemicals, Solvent-free methods: Microwave, Ultraviolet, and Solar.            Unit IV: Green catalysts: ionic liquids, zeolites, photo catalyst, PEG, nano catalyst, and biocatalyst.</p>			

**Module-3****(4 weeks/12 Hours)**

Unit V: Green solvents: Supercritical fluids, fluoruous phase, and non-aqueous solvents.

Unit VI: Scale-up effect, reactors, separators, Process intensification.

**Module-4****(2 weeks/6 Hours)**

Unit VII: Bio-conversion of renewable. Comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts.

**Reference Books:**

1. Handbook of Green Chemistry, Vol. 1 to 9 by P T Anastas, Wiley VCH.
2. Green Chemistry and Engineering: A Practical Design Approach by C J González and D J C Constable, Wiley.
3. Green Chemistry and Engineering: A Pathway to Sustainability by A E Marteel Parrish and M A Abraham, Wiley.
4. Green Chemistry for Environmental Sustainability by S K Sharma and A. Mudhoo, CRC Press.
5. Green Engineering: Environmentally Conscious Design of Chemical Processes by D T Allen and D R Shonnard, PHI.

**Course outcomes:**

1. Enlist different concepts of green technologies in a project.
2. Understand the principles of Energy efficient technologies.
3. Recognize the benefits of green fuels with respect to sustainable development.

<b>OECE6312</b>	<b>Mechanics of Solids</b>	<b>3-0-0</b>	<b>Credit-3</b>
<p><b>Module – I</b>            Stress, St. Venant's principle, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, stresses due to freely falling weight.</p> <p>Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.</p> <p>Analysis of Biaxial Stress. Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress.</p> <p>Strain Deformation: Two dimensional state of strain, Mohr's circle for strain, Principal strains and principal axes of strain, strain measurements, Calculation of principal stresses from principal strains.</p>			

**Module – II**

Stresses in thin cylinders, thin spherical shells under internal pressure -wire winding of thin cylinders. Thick cylinders subjected to internal and external pressures, compound cylinders. Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting.

**Module – III**

Theory of Columns: Eccentric loading of a short strut, Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio. Close - coiled helical springs.

Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum strain theory, total strain energy theory, maximum distortion theory, octahedral shear stress theory graphical representation and comparison of theories of failure.

**Module IV**

Unsymmetrical bending: Properties of beam cross section, slope of neutral axis, stresses and deflection in unsymmetrical bending, shear centre.

Curved Beam: Bending of beam with large initial curvature, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links.

**Text Books/Reference Books:**

1. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East-West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
4. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
5. Mechanics of Materials by R.C. Hibbeler, Pearson Education
6. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley Student Edition
7. Mechanics of Materials by James M. Gere, Thomson Learning
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India
9. Strength of Materials by S.S. Rattan, Tata McGraw Hill
10. Strength of Materials by R. Subramaniam, Oxford University Press
11. Advanced mechanics of solids by L.S. Srinath, McGraw Hill.
12. Advanced mechanics of materials, Kumar & Ghai, Khanna Publishers.

OECS6203	OOps Using C++	3-0-0	Credit-3
<p><b>Course Objective:</b> This course is aimed at mastering object oriented programming technique in software development and demonstrates these techniques in solution to different types of problems.</p> <p><b>Module –I (10 Hours)</b> Introduction to OOP, OOP Concepts, Overview of C++, C++ fundamentals, Classes, Objects, Inline functions, function Overloading, Scope Resolution Operator, Constructors ,Destructors, Static Members, Passing objects to functions, Function returning objects.</p> <p><b>Module – II (10 Hours)</b> Arrays, Pointers, this pointer, References, Dynamic memory Allocation, functions Overloading, Default arguments, Overloading Constructors, copy constructors, Pointers to Functions, Ambiguity in function overloading.</p> <p><b>Module –III (10 Hours)</b> Operator Overloading, Overloading of some special operators, Inheritance, Types of Inheritance, Protected members, Polymorphism, Virtual base Class, Virtual functions, Pure virtual functions, Abstract classes.</p> <p><b>Module – IV (8 Hours)</b> Class template, Generic classes, Function template, generic functions, Exception Handling, Exception handling options, Streams, Formatted I/O, C++ File I/O, Array based I/O, Standard Template Library (STL).</p> <p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. H. Schildt - C++ The Complete Reference, 4<sup>th</sup> Edition, Tata McGraw-Hill, New Delhi.</li> </ol> <p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. A. N Kanthane, Object Oriented Programming with ANSI &amp; Turbo C++, Pearson Education, New Delhi.</li> <li>2. Object Oriented Programming with C++, E. Balagurusamy, Mcgraw Hill Education</li> <li>3. Object Oriented Programming in C Robert Lafore – SAMS Publishing.</li> </ol> <p><b>Course Outcomes:</b> Students will be able to -</p> <ol style="list-style-type: none"> <li>1. Familiar with issues with software design.</li> <li>2. Be familiar to key concepts of object oriented programming.</li> <li>3. Have knowledge about C++ concepts related to good modular design.</li> <li>4. Implement patterns involving realization of abstract interfaces and polymorphism.</li> <li>5. Learn how to utilize Exceptions and standard template library.</li> </ol>			

OECS6331	CLOUD COMPUTING	3-0-0	Credit-3
<p><b>Course Objective:</b> This course gives students an insight into the basics of cloud computing along with virtualization, cloud computing is one of the fastest growing domain from a while now. It will provide the students basic understanding about cloud and virtualization along with it how one can migrate over it.</p> <p><b>Module-I</b> <span style="float: right;"><b>10 Hrs</b></span>            Evolution of Computing Paradigms - Overview of Existing Hosting Platforms, Grid Computing, Utility Computing, Autonomic Computing, Dynamic Datacenter Alliance, Hosting/ Outsourcing, Introduction to Cloud Computing, Workload Patterns for the Cloud, “Big Data”, IT as a Service, Technology Behind Cloud Computing,</p> <p><b>Module-II</b> <span style="float: right;"><b>10 Hrs</b></span>            A Classification of Cloud Implementations- Amazon Web Services - IaaS, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), VMware v Cloud - IaaS, v Cloud Express, Google AppEngine - PaaS, The Java Runtime Environment.</p> <p><b>Module-III</b> <span style="float: right;"><b>10 Hrs</b></span>            The Python Runtime Environment- The Datastore, Development Workflow, Windows Azure Platform - PaaS, Windows Azure, SQL Azure, Windows Azure AppFabric, Salesforce.com - SaaS / PaaS, Force.com, Force Database - the persistency layer, Data Security, Microsoft Office Live - SaaS, LiveMesh.com, Google Apps - SaaS, A Comparison of Cloud Computing Platforms, Common Building Blocks.</p> <p><b>Module-IV</b> <span style="float: right;"><b>8 Hrs</b></span>            Cloud Security – Infrastructure security – Data security – Identity and access management Privacy- Audit and Compliance.</p> <p><b>Text Book:</b></p> <ol style="list-style-type: none"> <li>1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, “Distributed and Cloud Computing from Parallel Processing to the Internet of Things”, Morgan Kaufmann, Elsevier, 2012</li> </ol> <p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Barrie Sosinsky, “Cloud Computing Bible” John Wiley &amp; Sons, 2010</li> <li>2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, “Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance”, O’Reilly 2009</li> </ol>			

<b>OEEE6313</b>	<b>Digital Signal Processing</b>	<b>3-0-0</b>	<b>3 Credits</b>
<p><b>Course Objectives:</b> To impart knowledge about the following topics:</p> <ol style="list-style-type: none"> <li>1. Signals and systems &amp; their mathematical representation.</li> <li>2. Discrete time systems.</li> <li>3. Transformation techniques &amp; their computation.</li> <li>4. Filters and their design for digital implementation.</li> </ol> <p><b>MODULE I</b> <span style="float: right;"><b>(12 Hours)</b></span> <b>Introduction:</b> Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, aliasing effect.</p> <p><b>The Z-Transform and Its Application:</b> Z-transform and its properties, inverse z-transforms; difference equation–Solution by z-transform, application to discrete systems–Stability analysis, frequency response–Convolution.</p> <p><b>MODULE II</b> <span style="float: right;"><b>(12 Hours)</b></span> <b>The Discrete Fourier Transform: Its Properties and Applications:</b> Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.</p> <p><b>Implementation of Discrete-Time Systems:</b> Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.</p> <p><b>MODULE III</b> <span style="float: right;"><b>(12Hours)</b></span> <b>Discrete Fourier Transform &amp; Computation:</b> Discrete Fourier Transform-properties, magnitude and phase representation-Computation of DFT using FFT algorithm–DIT &amp; DIF using radix 2 FFT–Butter fly structure.</p> <p><b>Design of Digital Filters:</b></p>			

FIR & IIR filter realization–Parallel & cascade forms. FIR design: Windowing Techniques–Need and choice of windows–Linear phase characteristics. Analog filter design–Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.

**MODULE IV****(6Hours)****Adaptive Filters:**

Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

**Text Books:**

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. S. K. Mitra, “Digital Signal Processing: A computer based approach”, McGraw Hill, 2011.
3. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.

**Reference Books:**

1. Digital Signal Processing, Manson H. Hayes, Schaum’s Outlines, TMH.
2. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
3. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
5. A.V. Oppenheim and R. W. Schaffer, “Discrete Time Signal Processing”, Prentice Hall, 1989.
6. L. R. Rabiner and B. Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, 1992.
7. J. R. Johnson, “Introduction to Digital Signal Processing”, Prentice Hall, 1992.
8. D. J. De Fatta, J. G. Lucas and W. S. Hodgkiss, “Digital Signal Processing”, John Wiley & Sons, 1988.

**Program Outcomes:**

1. Ability to understand the importance of Fourier transform, digital filters.
2. Ability to acquire knowledge on Signals and systems & their mathematical representation.
3. Ability to understand and analyze the discrete time systems.
4. Ability to analyze the transformation techniques & their computation.
5. Ability to understand the types of filters and their design for digital implementation.

<b>OEEC6314</b>	<b>Industrial Automation with PLC &amp; SCADA</b>	<b>3-0-0</b>	<b>Credits 3</b>
<b>COURSE OBJECTIVES</b>			
1. Gain the Knowledge of various skills necessary for Industrial applications of Programmable logic controller (PLC)			

2. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC )
3. Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices.

**MODULE-I****( 12 Hours)****Unit 1**

What is A PLC, Technical Definition of PLC, What are its advantages, characteristics functions of A PLC, Chronological Evolution of PLC, Types of PLC, Unitary PLC, Modular PLC, Small PLC, Medium PLC, Large PLC.

**Unit 2**

Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Processor Software / Executive Software, Multi asking, Languages, Ladder Language.

**MODULE-II****(12 Hours)****Unit 3**

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format.

**Unit 4**

Introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder design. Examples: Training Stopping, Multiplexer, DE multiplexers

**MODULE-III****(12 Hours)****Unit 5**

PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Count down (CTD).

**Unit 6**

PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems.

**MODULE-IV****(8 Hours)****Unit 7****SCADA Systems**

Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First generation-Monolithic, Second Generation-Distributed, Third generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification

System.

**Text Books:**

1. Madhu Chhanda Mitra, S.S Gupta, "PLC and Industrial automation", Pernam International pub. (Indian) Pvt. Ltd., 2011.

**Reference Books:**

1. Ronald L Krutz, "Securing SCADA System", Wiley Publication, 2012.
2. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2<sup>nd</sup> edition, 2006.

**Course Outcomes:**

1. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC).
2. Compute the extent and nature of electronic circuitry in Programmable logic controller (PLC) and SCADA including monitoring and control circuits for Communication and Interfacing.

OEME6316	Introduction to Composite Materials	3-0-0	Credit-3
<p><b>Course objective:</b></p> <ol style="list-style-type: none"> <li>1. Introduce students to the concepts of modern composite materials.</li> <li>2. Equip them with knowledge on how to fabricate and carry out standard mechanical test on composites.</li> <li>3. To make student understand the basic stress and strain relations in composite materials.</li> </ol> <p><b>Module I (10hours)</b> Introduction: Classification and characteristics of composite materials, mechanical behaviour of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites. Processing – Pultrusion; Filament winding; Prepreg technology; Injection &amp; compression moulding; Bag moulding; Resin transfer moulding.</p> <p><b>Module II (12hours)</b> Macromechanics of a Lamina: Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.</p> <p><b>Module III (12hours)</b> Micromechanics of a Lamina: Rule of mixture; Volume &amp; mass fractions; Density &amp; void content. Evaluation of the nine mechanical and four hygrothermal constants: four elastic moduli(Strength of Materials Approach), five strength parameters, two coefficients of thermal expansion and two coefficients of moisture expansion of a unidirectional lamina from the individual properties of the fiber and the matrix.</p>			

**Module IV****(10hours)**

Analysis: Classical lamination theory; Stress analysis of composite laminates; Failure predictions – Maximum stress theory; Maximum strain theory; Tsai-Hill theory; Modes of failure of composites; First ply failure; Partial ply failure; Total ply failure.

**Text Books:**

1. Mechanics of Composite Materials, R.M. Jones, Mc. Graw Hill Book Co.
2. Mechanics of Composite Materials, A. K. Kaw, CRC Press.
3. Mechanics of composite materials & structures, M Mukhopadhyay, Universities Press.

**COURSE OUTCOME**

1. (Knowledge based) identify and explain the types of composite materials and their characteristic features;
2. Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application;
3. Understand and explain the methods employed in composite fabrication;
4. Appreciate the theoretical basis of the experimental techniques utilized for failure mode of composites.
5. (Skills) develop expertise on the applicable engineering design of composite;
6. Learn simple micromechanics and failure modes of composites.

<b>OEMT6315</b>	<b>Nanomaterials</b>	<b>3-0-0</b>	<b>Credits 3</b>
<p><b>Objectives of the Course:</b> To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications.</p> <p><b>Module 1:</b> <span style="float: right;"><b>(12 Hours)</b></span> Introduction: Types of nanomaterials, emergence of nanotechnology, bottom-up and top-down approaches, challenges in nanotechnology. Nanoparticles: synthesis of metallic nanoparticles, semiconductor nanoparticles, oxide nanoparticles (sol-gel processing); vapour phase reactions, solid phase segregation. Nanowires: Synthesis of nanowires by evaporation – condensation growth, VLS or SLS growth, high energy ball milling, cryo rolling, and equal channel angular extrusion, template based synthesis, electrospinning, types of lithography. Thin Films: fundamentals of film growth, PVD, CVD and ALD.</p> <p><b>Module-II</b> <span style="float: right;"><b>(12 Hours)</b></span> Specific nano materials and their applications: Carbon nanostructures (Nanotubes, nanohorns, graphene, buckyballs etc.), Semiconducting nanomaterials – Quantum confinement, Quantum wells, quantum wires and quantum dots. Magnetic nanomaterials – super paramagnetism Ferroelectric, nano ceramics Super plasticity Nanocomposites and their types.</p>			

**Module III:****(12 Hours)**

Thermodynamics of nanomaterials, Mechanical property aspects of nanomaterials, inverse Hall-Petch relationship, nano indentation, electrical properties of nanomaterials, optical properties of nanomaterials, magnetic properties of nanomaterials, Characterization techniques from the perspective of nanomaterials: BET, XRD, SEM, TEM, AFM, EDS, WDS, LEED, XPS etc.

**Module IV:****(06 Hours)**

Application of nanomaterials such as medicine, energy, environment, information and communication technology.

**Suggested text books:**

1. Rishal Singh, S.M. Gupta, Introduction to nanotechnology, Oxford university press, (2016).
2. Dieter Vollath.\_ Nanomaterials: An Introduction to Synthesis, Properties and Applications, Second Edition. Published 2013 by Wiley-VCH Verlag GmbH & Co. KGaA.

**Suggested reference books:**

1. Charles Poole and Frank Owens, Introduction to Nanomaterials, Wiley 2007
2. Cao G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press
3. Gagotsi Y., Nanomaterials Handbook, (Ed.), Taylor and Francis.
4. Edlstein and Cammarate, Nano Materials Synthesis, Properties and Applications.
5. Bandyopadhyay A.K., Nano Materials, New age Publications.
6. Pradeep T., Nano - The Essentials, TMH.
7. Koch,C. Nanostructured Materials: Processing, Properties and applications, William Andrew Publishing.

**Course Outcomes**

After completing this course, the student should be able to:

1. Indicate the differences between nanomaterials and conventional materials
2. Indicate how specific synthesis techniques can result in nanomaterials
3. Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
4. Describe how specific characterization techniques can be used to analyze nanomaterials

<b>OEPD6317</b>	<b>POWDER METALLURGY</b>	<b>3L-0T-0P</b>	<b>3 Credits</b>
<b>Course Objective</b>			

The course is a specialized course of the metallic materials area. The scope is to provide the necessary knowledge on the metallic part production by metal powders. It covers subjects such as metal powder characterization, metal powder production methods, and powder metallurgy processing steps.

**Module I****[12]**

Introduction Historical and modern developments in Powder Metallurgy. Advantages, limitations and applications of Powder Metallurgy. Basic Steps for Powder Metallurgy. Characteristics of metal powder Chemical composition, Particle size, shape and size distribution, Characteristics of powder mass such as apparent density, tap density, flow rate, friction index. Properties of green compacts and sintered compacts

**Module II****[10]**

Powder Characterization Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, compressibility, green Strength, pyro phorocity and toxicity.

**Module III****[10]**

Powder Compaction Methods Basic aspects, types of compaction presses, compaction tooling and role of lubricants, Single and double die compaction, isostatic pressing, Hot pressing. Powder Forming Powder rolling, powder forging, powder extrusion and explosive forming technique

**Module IV****[10]**

Sintering Definition, stages, effect of variables, sintering atmospheres and furnaces, Mechanism, liquid-phase sintering, Secondary operations. Sintered Products Study of sintered bearings, cutting tools, metallic filters, friction and antifricition parts and electrical contact materials. Defects in Powder metallurgy processed materials and their processing to minimize defects: Friction stir processing etc.

**Text Books:**

1. Introduction to Powder Metallurgy, A. K. Sinha, Dhanpatrai Publication.
2. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, CRC Press
3. Powder Metallurgy, ASM Handbook, Vol-VII.

**Reference Books:**

1. Powder Metallurgy: Science, Technology and Applications, P. C. Angelo, R. Subramanian
2. Powder Metallurgy, W.D. Jones
3. Principles of Powder Metallurgy, T. Shukerman
4. Handbook of Powder Metallurgy :- H.H. Hausner

**Course Outcomes:**

Upon successful completion of the course, student will able to:

1. Acquire the knowledge of Powder Metallurgy History, Applications and its importance.

2. Measure the various powder characteristics like apparent density; tap density, flow rate, friction index.
3. Acquainted the knowledge of metal powder production methods.
4. Aware about the powder characterization techniques.
5. Understand the basic methods of Powder compaction for green compact.

OEMA6207	Numerical Methods	3-0-0	Credit-3
<p><b>Module –I</b> <span style="float: right;"><b>(12 Hours)</b></span>            Number system, Floating point arithmetic, Errors, truncation error, Bisection method, Scant method, Regula-Falsi Method, Newton-Raphson method, Muller method, Rate of Convergence, Lagranges’s interpolation, Newton divided difference interpolation, Newton’s forward and backward interpolation, Piecewise and Spline interpolation.</p> <p><b>Module -II :</b> <span style="float: right;"><b>(12 Hours)</b></span>            Numerical integration: Romberg integration, Gaussian Quadrature (2-point, 3-point), Newton- Cotes rules. Numerical solution to ordinary differential equations: Taylor’s series methods, Euler method, modified Euler method Runge - Kutta methods, predictor- corrector method, multistep methods.</p> <p><b>Module -III:</b> <span style="float: right;"><b>(8 Hours)</b></span>            Matrix eigen value problem, power method, Rayleigh Quotient, shifted power method, inverse power method, QR method.</p> <p><b>Module IV:</b> <span style="float: right;"><b>(8 Hours)</b></span>            Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method. Hyperbolic Partial Differential Equation: Explicit Method, Implicit method. Elliptic Partial Differential Equation: Finite-difference method.</p> <p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Jain M.k, Iyengar S.R.K &amp; Jain R.K, Numerical methods for Scientific and Engineering Computation, 6<sup>th</sup> Edition, New Age International(P) Ltd.</li> <li>2. Atkinson Kendall E, An introduction to Numerical Analysis, 2<sup>nd</sup> Edition, John Wiley &amp; Sons</li> </ol> <p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Fusset L.V, Applied numerical Analysis Using MATLAB, 2<sup>nd</sup> Edition, PEARSON</li> <li>2. Chapra Steven C &amp; Canale Raymond P., Numerical methods for Engineers, 7<sup>th</sup> Edition, McGraw Hill Education.</li> </ol>			



**INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG**  
**B.TECH SYLLABUS for ELECTRONICS AND TELECOMMUNICATION ENGINEERING**  
 (Admission Batch: 2018-19 Onwards)  
 6<sup>th</sup> Semester

<b>HSHM3306</b>	<b>Enhancing Soft Skills and Personality</b>	<b>2-0-0</b>	<b>Credit-2</b>
<p><b>Course Objective</b></p> <p>The course aims to cause an enhanced awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality. Hard or technical skills help securing a basic position in one's life and career. But only soft skills can ensure a person retain it, climb further, reach a pinnacle, achieve excellence, and derive fulfillment and supreme joy. Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The focus of this course is on interpersonal and management skills.</p>			
<p><b>Module I</b> <span style="float: right;"><b>10 Hours</b></span></p> <ul style="list-style-type: none"> <li>•Highlights of Developing Soft Skills and Personality Course-1-24</li> <li>•Highlights of Developing Soft Skills and Personality Course-25-48</li> <li>•Definitions and Types of Mindset</li> <li>•Learning Mindsets</li> <li>•Secrets of Developing Growth Mindsets</li> <li>•Importance of Time and Understanding Perceptions of Time</li> <li>•Using Time Efficiently</li> <li>•Understanding Procrastination</li> <li>•Overcoming Procrastination</li> <li>•Don't Say "Yes" to Make Others Happy!</li> </ul>			
<p><b>Module II:</b> <span style="float: right;"><b>10 Hours</b></span></p> <ul style="list-style-type: none"> <li>• Types of People</li> <li>• How to Say "No"</li> <li>• Controlling Anger</li> <li>• Gaining Power from Positive Thinking-1</li> <li>• Gaining Power from Positive Thinking-2</li> <li>• What Makes Others Dislike You?</li> <li>• What Makes Others Like You?-1</li> <li>• What Makes Others Like You?-2</li> <li>• Being Attractive-1</li> <li>• Being Attractive-2</li> </ul>			

**Module III****10 Hours**

- Common Errors-1
- Common Errors-2
- Common Errors-3
- Common Errors-4
- Common Errors-5
- Humour in Communication
- Humour in the Workplace
- Function of Humour in the Workplace
- Money and Personality
- Managing Money

**Module IV****10 Hours**

- Health and Personality
- Managing Health-1: Importance of Exercise
- Managing Health-2: Diet and Sleep
- Love and Personality
- Managing Love
- Ethics and Etiquette
- Business Etiquette
- Managing Mind and Memory
- Improving Memory
- Care for Environment
- Highlights of the Course

**Books for Reference:**

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: Harper Collins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

PCEC4309	Control System	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>To teach the fundamental concepts of control systems and mathematical modelling of the system.</li> <li>To understand the practical control problems related to industrial applications.</li> </ol> <p><b>MODULE-I (12 Hours)</b></p> <p><b>Unit 1</b>  <b>Introduction to Control Systems:</b> Basic Concepts of Control Systems, Open loop and closed loop systems, Servo Mechanism/Tracking System, Regulators, Mathematical Models of Physical Systems: Differential Equations of Physical Systems: Mechanical Translational Systems, Mechanical Rotational systems, Gear Trains, Electrical Systems, Analogy between Mechanical and electrical quantities, Thermal systems, fluid systems, Derivation of Transfer functions, Block Diagram Algebra, Signal flow Graphs, Mason's Gain Formula.</p> <p><b>Unit 2</b>  <b>Feedback characteristics of Control Systems:</b> Effect of negative feedback on sensitivity, bandwidth, Disturbance, linearizing effect of feedback, Control Components: D.C. Servomotors.</p> <p><b>MODULE-II (12 Hours)</b></p> <p><b>Unit 3</b>  <b>Time response Analysis of Standard Test Signals:</b> Time response of first order systems to unit step and unit ramp inputs. Time Response of Second order systems to unit step input, Time Response specifications, Steady State Errors and Static Error Constants of different types of systems. Generalized error series and Generalized error coefficients, Stability and Algebraic Criteria, concept of stability, Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, Application of the Routh stability criterion to linear feedback system, Relative stability by shifting the origin in s-plane.</p> <p><b>Unit 4</b>  <b>Root locus Technique:</b> Root locus concepts, Rules of Construction of Root locus, Determination of Roots from Root locus for a specified open loop gain, Root contours.</p> <p><b>MODULE-III (12 Hours)</b></p> <p><b>Unit 5</b>  <b>Frequency Response Analysis:</b> Frequency domain specifications, correlation between Time and Frequency Response with respect to second order system, Polar plots, Bode plot. Determination of Gain Margin and Phase Margin from Bode plot.</p> <p><b>Unit 6</b>  <b>Stability in frequency domain:</b> Principle of argument, Nyquist stability criterion, Application of Nyquist stability criterion for linear feedback system.</p>			

**MODULE-IV****(8 Hours)****Unit 7****Closed loop frequency response:** Constant M circles, Constant N-Circles, Nichol's chart.**Controller:** Concept of Proportional, Derivative and Integral Control actions, P, PD, PI, PID controllers. Zeigler-Nichols method of tuning PID controllers.**Text Books:**

1. I.J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 6<sup>th</sup> Edition, 2010.

**Reference Books:**

1. K. Ogata, "Modern Control Engineering", PHI, 5<sup>th</sup> edition, 2010.
2. A Nagoorkani, "Control Systems", RBA Publication, 2017.

**Course Outcomes:**

1. Understand and use model of physical systems in forms suitable for use in the analysis and design of control systems.
2. To understand the fundamentals of (feedback) control systems.

<b>PCEC4310</b>	<b>Microwave Engineering</b>	<b>3-0-0</b>	<b>Credits 3</b>
-----------------	------------------------------	--------------	------------------

**COURSE OBJECTIVES**

1. To understand various IEEE frequency bands used in communication.
2. To understand the working of Transmission line, wave guides, resonators, Dividers, Directional Couplers, Attenuators, Isolators, Circulators and its related concepts.
3. To get ideas on microwave devices and their operations.

**MODULE-I****(12 Hours)****Unit 1**

Introduction to Microwave Engineering, Standard frequency bands as per IEEE standard, Different forms of Maxwell's Equations.

**Transmission Line Theory:**

Derivation of Telegrapher Equations (in time domain) from Lumped Element transmission line, Wave Propagation on a Transmission line, The Lossless Transmission line, Field Analysis of Co-axial Transmission Lines: Calculation of parameters like R, L, C and G of Co-axial Transmission line, The Terminated lossless transmission line, The Smith Chart. Solution of Transmission line problems using Smith chart. Single Stub and Double Stub matching. Brief Discussion on Quarter-wave Transformer, Lossy Transmission Line:

Fundamental ideas on low-loss line, Distortion less line and Terminated Lossy line.

### Unit 2

**Wave Guides:** Fundamental ideas on Waveguides and its Type. Rectangular Waveguide: Field solution for  $TE_{mn}$  and  $TM_{mn}$  modes, Design of Rectangular waveguides to support Dominant  $TE_{10}$  only. TEM mode in Co-axial line.

## MODULE-II

(12 Hours)

### Unit 3

**Microwave Network Analysis:** Scattering matrix and its Properties. Transmission (ABCD) matrix, Relation of ABCD matrix to Z and Y-matrix.

**Microwave Resonators:** Rectangular Waveguide Cavity Resonator: Resonant frequencies of cavity supporting. Dominant mode only. Excitation of resonators (in principle only).

### Unit 4

**Power Divider, Directional Coupler, Attenuator, Isolator and Circulator:** Basic properties of Power Divider and Directional Coupler, T-junction power divider, E-plane Tee, H-plane Tee, Magic Tee (principle only), Wilkinson power divider, Waveguide-Directional Couplers.

Fixed and Precision variable Attenuator, Isolator, Circulator (Principle of Operation only)

## MODULE-III

(12 Hours)

### Unit 5

**Microwave Sources:** Reflex Klystron: Velocity Modulation, Electronic Admittance, Output Power output and frequency.

Multi Cavity Magnetron: Principle of operation, Rotating field,  $\pi$ -mode of operation, Frequency of oscillation.

### Unit 6

The ordinary type (O-type) travelling wave tube (TWT): Construction features, principle of operation as an amplifier, Gunn oscillator (principle).

## MODULE-IV

(8 Hours)

### Unit 7

**Microwave Propagation and radiation hazards::**

Atmospheric Effects, Ground Effects, Plasma Effects. Hazards of EM radiation, Radiation hazard limits, radiation protection

### Text Books:

1. D. M. Pozar, "Microwave Engineering", 3<sup>rd</sup> Edition, John Willy & Sons (Selected portions from Chapters 2, 3, 4, 6, 7, 9 & 14.), 2003

### Reference Books:

1. Reich, Oudong and Others "Principles of Microwave Engineering", 3rd Ed, 2005.
2. Annapurna Das and S, K. Das, "Microwave Engineering", Tata McGraw-Hill, 2009.
3. Sammuel Y, Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson 2006.

**Course Outcomes:**

1. To demonstrate, analyze and solve problems related to transmission line model and also able to solve problems using smith chart.
2. Students will be able to demonstrate the principle of operation of microwave components, devices and sources.
3. To learn about adverse effects on human body.

<b>PEEC5307</b>	<b>Computer Network and Data Communication</b>	<b>3-0-0</b>	<b>Credits 3</b>
-----------------	--	--------------	------------------

**COURSE OBJECTIVES**

1. To get an understanding on the fundamentals of networks and functionality of each layer.
2. To understand the responsibility for delivery of packets from source to destination.
3. To learn flow control and conjunction control algorithm.
4. To understand the responsibility for providing services to the users.

**MODULE-I****(12 Hours)****Unit 1****Fundamentals And Link Layers**

Over View Of Data Communication, Network And Its Type, Layered Architecture and Protocol Architecture. Physical Layer - Transmission media- Switching - Telephone Network - Dial – up Modems – Digital Subscriber Lines.

**Unit 2**

Data Link Layer- Error Detection and Correction - Data Link Control - Medium Access Control - LANs – IEEE 802.3 - IEEE 802.5 – IEEE 802.11 - Bluetooth - Frame Relay - ATM

**MODULE-II****(12 Hours)****Unit 3****Network Layer**

Network Layer Services, IPV4 addresses, IPV6 addresses, Internet Protocol - IPV4datagram, IPV6 packet format and advantages – Transition From IPV4 To IPV6.

**Unit 4**

Network Layer Protocols – ARP – RARP - IGMP – ICMP, Routing - Unicast Routing Protocols - Multicast Routing Protocols.

**MODULE-III****(12 Hours)****Unit 5****Transport Layer**

Connection Management - Transmission Control Protocol (TCP) -User Datagram Protocol (UDP).

### Unit 6

Principles of reliable data transfer - Principles of congestion control - Flow control.

### MODULE-IV

(8 Hours)

### Unit 7

#### Application Layer

Domain Name System (DNS), Electronic Mail -SMTP - POP3 – IMAP4, File Transfer Protocol (FTP), WWW, HTTP, SNMP. Need For Cryptography And Network Security.

#### Text Books:

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw-Hill, 5<sup>th</sup> Edition, 2013.

#### Reference Books:

1. W. Stallings, “Wireless Communication and Networks”, Pearson, 8<sup>th</sup> Edition, 2007
2. James .F. Kurose, Keith. W. Ross, “Computer Networking - A Top Down Approach Featuring The Internet”, Seventh Edition, Pearson Education, 2016 ..
3. A Leon-Garcia, I Widjaja “Communication Networks”, McGraw Hill Education India, 2<sup>nd</sup> Edition, 2003.

#### Course Outcomes:

1. Understand each layer’s responsibilities and learn about physical layer and data link layer transmission.
2. Learn host to host delivery.
3. Learn port to port delivery.
4. Learn different services which enable user or software to get access to the network.

PEEC5308	Electrical Machine & Power Devices	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To provide a solid foundation in transformer and DC generator</li> <li>2. To understand the concept of single phase and three phase induction motors.</li> <li>3. To have the working knowledge of DC motor and three phase synchronous machines.</li> <li>4. To provide better understanding of power semiconductor devices.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b></p> <p><b>Transformer:</b></p> <p>Single Phase Transformer: Constructional Features, EMF Equation, Turn Ratio, Open and short circuit test equivalent circuit, losses and efficiency, condition for maximum efficiency, voltage regulation, and approximate expression for voltage regulation. Phasor diagram, Introduction to three phase transformer.</p>			

**Unit 2****DC Generator:**

Constructional Features; Principle of operation, armature windings, Methods of Excitation; Expression for EMF Induced and Torque Developed in the Armature. Lap and wave windings, No Load Characteristics. Critical Resistance and Critical Speed; Losses and Efficiency.

**MODULE-II****(12 Hours)****Unit 3**

**DC Motor:** Principle of operation, Back E.M.F., Torque equation, Speed Armature Current, Torque Armature Current and Speed Torque Characteristic for (i) Separately Excited DC Motor, (ii) DC Shunt Motor, (iii) DC Series Motor, and (iv) DC Compound Motor, Speed control and Starting of DC shunt and DC series motors. Constant & Variable losses, calculation of efficiency, condition for maximum efficiency.

**Unit 4**

**Three phase synchronous machines:** Constructional Features; Principle of operation as Alternator and Synchronous Motor; Synchronous Impedance; Voltage Regulation by Synchronous Impedance Method; Power-Angle curve; Synchronization of Alternators; Torque Expression and Phasor Diagram for Synchronous Motor.

**MODULE-III****(12 Hours)****Unit 5**

**Single phase induction motor:** Theory of operation (Double revolving field theory, equivalent circuit, Determination of parameters) Methods of starting, split phase starting, Repulsion starting, shaded pole starting, performance characteristics.

**Unit 6**

**Three phase induction motors:** Construction and principle of operation, 3 phase Induction Motor, general phasor diagram, equivalent circuit, power and torque relations, condition for maximum torque, effect of rotor resistance on speed torque characteristics.

**MODULE-IV****(8 Hours)****Unit 7**

**Power semiconductor devices:** V-I characteristic of devices: Thyristor family: SCR, DIAC, TRIAC, GTO; Different Triggering Methods of SCR. Power BJTs. Power MOSFETs - Insulated Gate Bipolar Transistors (IGBTs) - Basic Structure and VI Characteristics.

**Text Books:**

1. D P Kothari & I J Nagrath, "Electric Machines", Tata McGraw Hill, 4th edition, 7 July 2010.

**Reference Books:**

1. J.B. Gupta, "Electrical Machine", S K Kataria and Sons publications, Reprint 2012 edition, 2012.
2. M H Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, 4th edition, 2006.

3. P S Bimbhra, "Electrical Machinery", Khanna Publishers, 7th edition, 2009.

**Course Outcomes:**

1. Explain the importance of transformer and DC generator.
2. Demonstrate the concept of single phase and three phase induction motors.
3. Explain the working of DC motor and three phase synchronous machines.
4. Understand the basic knowledge of power semiconductor devices.

PEEC5309	Mechatronics	3-0-0	Credits 3
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. Understand key elements of Mechatronics system, its block diagram representation.</li> <li>2. Understand principles of sensors, transducers, encoders and actuators and its characteristics.</li> <li>3. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial applications.</li> <li>4. Understand the system modelling and analysis in time domain and frequency domain.</li> </ol>			
<p><b>MODULE-I</b></p>		<p><b>(12 Hours)</b></p>	
<p><b>Unit 1</b></p> <p><b>Fundamental of Mechatronics:</b> Definition and concepts of Mechatronics, Conventional system vs. mechatronic system, Evolution of Mechatronics.</p>			
<p><b>Unit 2</b></p> <p>Hardware components for Mechatronics. Need and Role of Mechatronics in Design, Manufacturing and Factory Automation.</p>			
<p><b>MODULE-II</b></p>		<p><b>(12 Hours)</b></p>	
<p><b>Unit 3</b></p> <p><b>Sensors:</b></p> <p>An introduction to sensors. Principle of operation, Difference between transducer and sensors. Sensor types- Transducer signal conditioning sensor, velocity and motion sensor, force sensor, fluid pressure sensor, liquid flow sensor, liquid level sensor, temperature sensor.</p>			
<p><b>Unit 4</b></p> <p><b>Transducers:</b></p> <p>Introduction to transducers. Transducer types – photo emissive transducer, photo conductive transducer, photovoltaic transducer, thermistors, thermocouple, inductive transducer, capacitive transducer, piezoelectric transducer, hall effect transducers, ionization transducer, Use of sensor and transducer for specific purpose in mechatronics.</p>			

**MODULE-III****(12 Hours)****Unit 5****Actuators and encoders:**

Electric motors: D.C. Motors, Stepper motor. Hydraulic actuators, Pneumatic actuators. Principle of operation of encoders, Types of encoders- incremental encoder, optical encoder, bimetallic strip encoder, strain gauge encoder, load cell encoder.

**Unit 6****Programmable Logic Controller:**

Basic Structure- Programming: Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling, Analog input / output , PLC Selection & Application.

**MODULE-IV****(8 Hours)****Unit 7****MEMS and Microsystems:**

Overview of MEMS and Microsystems. Micromachining techniques: silicon as a material for micromachining, photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, wafer bonding, packaging.

**Microsystems modelling and Design:**

Mechanics of deformable bodies. Energy method. Estimation of stiffness and damping for different microstructures. Modelling of electromechanical system, it's analysis in time domain and frequency domain, pull-in voltage. Applications of MEMS.

**Text Books:**

1. Mahalik N.P, "Mechatronics: Principles, Concepts and applications", Tata McGraw Hill, 3<sup>rd</sup> edition (Indian), 2012.
2. Appu Kuttan, "Introduction to Mechatronics", Oxford University, 2007.

**Reference Books:**

1. RK Rajput, "A Textbook of Mechatronics", S. Chand Publishing, 1<sup>st</sup> Edition, 2007.
2. Ananthasuresh & Gopalkrishnan, "Micro and Smart Systems", Wiley India, 2012
3. A.Smaili & F Mrad, "Applied Mechatronics", Oxford University Press, 1<sup>st</sup> Edition 2007.
4. S. D. Senturia, "Microsystem Design", Springer, 1<sup>st</sup> edition 2<sup>nd</sup> reprint 2004

**Course Outcomes:**

1. To model, analyze, and control engineering systems.
2. Identify sensors, transducers, and actuators to monitor and control the behaviour of a process or product.
3. Develop PLC programs for a given task.
4. Evaluate the performance of mechatronics systems.

## MANDATORY COURSE

MCGN9305	Environmental Science	2-0-0	Credit-0
<p><b>Unit 1: Multidisciplinary nature of environmental studies</b>            Definition, scope and importance), Need for public awareness.</p> <p><b>Renewable and non-renewable resources</b>            Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.</p> <p><b>Unit 2: Ecosystems</b>            Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems:-</p> <ol style="list-style-type: none"> <li>a. Forest ecosystem</li> <li>b. Grassland ecosystem</li> <li>c. Desert ecosystem</li> <li>d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)</li> </ol> <p><b>Unit 3: Biodiversity and its conservation</b></p> <ul style="list-style-type: none"> <li>• Introduction – Definition: genetic, species and ecosystem diversity.</li> <li>• Bio geographical classification of India</li> <li>• Biodiversity at global, National and local levels.</li> <li>• India as a mega-diversity nation</li> <li>• Hot-spots of biodiversity.</li> <li>• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.</li> <li>• Endangered and endemic species of India</li> <li>• Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.</li> </ul> <p><b>Unit 4: Environmental Pollution</b> Cause, effects and control measures of :-            Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.</p> <p><b>Unit 5: Social Issues and the Environment</b>            Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.</p>			

**Text Books**

1. Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India.
2. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication.
3. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India.

**MANDATORY COURSE**

MCHM9306	Universal Human Values	2-0-0	Credit-0
<p><b>Objective:</b></p> <ol style="list-style-type: none"> <li>1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education.</li> <li>2. To sensitize the student towards issues in society and nature.</li> <li>3. To Strengthen self-reflection to know what the students ‘really want to be’ in their life and profession.</li> <li>4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life.</li> </ol> <p><b>Module I</b> <span style="float: right;"><b>10 Hours</b></span></p> <ol style="list-style-type: none"> <li>1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process;</li> <li>2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations.</li> <li>3. Method to fulfill the human aspirations: understanding and living in harmony at various levels.</li> </ol> <p><b>Module II</b> <span style="float: right;"><b>10 Hours</b></span></p> <ol style="list-style-type: none"> <li>1. Human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Self (‘I’) and ‘Body’ - <i>Sukh and Suvidha</i></li> <li>2. Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), the characteristics and activities of ‘I’ and harmony in ‘I’,</li> <li>3. Harmony of I with the Body: <i>Sanyam</i> and <i>Swasthya</i>; Needs of Body and Psyche: <i>Sanyam</i> and <i>Swasthya</i></li> </ol> <p><b>Module III</b> <span style="float: right;"><b>12 Hours</b></span></p> <ol style="list-style-type: none"> <li>1. Harmony in the Family, values in human-human relationship; Trust (<i>Vishwas</i>) and Respect (<i>Samman</i>) as the foundational values of relationship, meaning of <i>Vishwas</i> and <i>Samman</i></li> </ol>			

2. Harmony in the society: *Samadhan, Samridhi, Abhay, Sah-astitva*, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature
3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education,

**Module IV****08 Hours**

1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management
2. Strategy for transition from the present state to Universal Human Order
3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

**Text Book:**

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

**References Books:**

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

**Course Outcome:**

On completion of this course, the students will be able to:

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

**HONOURS**

<b>HNEC0304</b>	<b>Cognitive Radio</b>	<b>3-1-0</b>	<b>Credits 4</b>
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To introduce the basics of the software defined radios.</li> <li>2. To learn the design of the wireless networks based on the cognitive radios.</li> <li>3. To understand the concepts of wireless networks and next generation networks.</li> <li>4. To provide comprehensive coverage of hardware and software architecture of software defined radio.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b> <b>Introduction to Software Defined Radio</b> Definitions and potential benefits, software radio architecture evolution, technology tradeoffs.</p> <p><b>Unit 2</b> Architecture implications, Essential functions of the software radio, Basic SDR.</p> <p><b>MODULE-II</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 3</b> <b>SDR Architecture</b> Hardware Architecture, Computational processing resources, Software Architecture, Top level component interfaces Interface topologies among plug and play modules.</p> <p><b>Unit 4</b> <b>Introduction to Cognitive Radios</b>  Marking radio Self-aware, Cognitive techniques – Position awareness, Environment awareness in cognitive radios, Optimization of radio resources, Artificial Intelligence Techniques.</p> <p><b>MODULE-III</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 5</b> <b>Cognitive Radio Architecture</b> Cognitive Radio – Functions, Components and design rules, Cognitive cycle, Orient, Plan, decide and act phases, Inference Hierarchy,</p> <p><b>Unit 6</b> Architecture maps, Building the Cognitive radio Architecture on Software defined Radio Architecture.</p> <p><b>MODULE-IV</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 7</b> <b>Next Generation Wireless Networks</b> The XG Network architecture, Spectrum Allocation Techniques- Spectrum Sensing, Spectrum Sharing, Spectrum Management, Spectrum Mobility, Upper Layer issues, Cross-layer design. Network attacks mitigation in CRN, IEEE 802.22 (WRAN).</p>			

**Text Books:**

1. Joseph MitolaIII, “Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering”, John Wiley & Sons Ltd. 2000.

**Reference Books:**

1. Thomas W. Rondeau, Charles W. Bostain, “Artificial Intelligence in Wireless communication”, ARTECH HOUSE .2009.
2. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, “Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey” Elsevier Computer Networks, May 2006.
3. Simon Haykin, “Cognitive Radio: Brain –Empowered Wireless Communications”, IEEE Journal on selected areas in communications, Feb 2005.

**Course Outcomes:**

1. To describe the basics of the software defined radios.
2. Capable of designing wireless networks based on the cognitive radios.
3. Able to explain the concepts behind the wireless networks and next generation networks.

**MINOR**

<b>MNEC0304</b>	<b>Computer Network and Data Communication</b>	<b>3-1-0</b>	<b>Credits 4</b>
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To get an understanding on the fundamentals of networks and functionality of each layer.</li> <li>2. To understand the responsibility for delivery of packets from source to destination.</li> <li>3. To learn flow control and conjunction control algorithm.</li> <li>4. To understand the responsibility for providing services to the users.</li> </ol> <p><b>MODULE-I</b> <span style="float: right;"><b>(12 Hours)</b></span></p> <p><b>Unit 1</b> <b>Fundamentals And Link Layers</b> Over View Of Data Communication, Network And Its Type, Layered Architecture and Protocol Architecture. Physical Layer - Transmission media- Switching - Telephone Network - Dial – up Modems – Digital Subscriber Lines.</p> <p><b>Unit 2</b> Data Link Layer- Error Detection and Correction - Data Link Control - Medium Access Control - LANs – IEEE 802.3 - IEEE 802.5 – IEEE 802.11 - Bluetooth - Frame Relay - ATM</p> <p><b>MODULE-II</b> <span style="float: right;"><b>(12 Hours)</b></span></p>			

**Network Layer****Unit 3**

Network Layer Services, IPV4 addresses, IPV6 addresses, Internet Protocol - IPV4 datagram, IPV6 packet format and advantages – Transition From IPV4 To IPV6.

**Unit 4**

Network Layer Protocols – ARP – RARP - IGMP – ICMP, Routing - Unicast Routing Protocols - Multicast Routing Protocols.

**MODULE-III****(12 Hours)****Unit 5****Transport Layer**

Connection Management - Transmission Control Protocol (TCP) - User Datagram Protocol (UDP).

**Unit 6**

Principles of reliable data transfer - Principles of congestion control - Flow control.

**MODULE-IV****(12 Hours)****Unit 7****Application Layer**

Domain Name System (DNS), Electronic Mail -SMTP - POP3 – IMAP4, File Transfer Protocol (FTP), WWW, HTTP, SNMP. Need For Cryptography And Network Security.

**Text Books:**

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw-Hill, 5<sup>th</sup> Edition, 2013.

**Reference Books:**

1. W. Stallings, “Wireless Communication and Networks”, Pearson, 8<sup>th</sup> Edition, 2007
2. James .F. Kurose, Keith. W. Ross, “Computer Networking - A Top Down Approach Featuring The Internet”, Seventh Edition, Pearson Education, 2016 ..
3. A Leon-Garcia, I Widjaja “Communication Networks”, McGraw Hill Education India, 2<sup>nd</sup> Edition, 2003.

**Course Outcomes:**

1. Understand each layer responsibility and get idea about physical layer and data link layer transmission.
2. Learn host to host delivery.
3. Learn port to port delivery.
4. Learn different services which enable user or software to get access to the network.

**PRACTICAL / SESSIONAL**

<b>PCEC7309</b>	<b>Control &amp; Instrumentation Lab</b>	<b>0-0-3</b>	<b>Credits 2</b>
<p><b>LIST OF EXPERIMENTS:</b></p> <p><b>Control:</b></p> <ol style="list-style-type: none"><li>1. Study of a dc motor driven position control system</li><li>2. Study of speed torque characteristics of two phase ac servomotor and determination of its transfer function</li><li>3. Obtain the frequency response of a lag and lead compensator</li><li>4. To observe the time response of a second order process with P, PI and PID control and apply PID control to servomotor</li><li>5. To study the characteristics of a relay and analyze the relay control system (Phase Plane)</li><li>6. To study and validate the controllers for a temperature control system</li></ol> <p><b>Instrumentation:</b></p> <ol style="list-style-type: none"><li>1. Measurement of unknown resistance, inductance and capacitance using bridges</li><li>2. To plot the displacement-voltage characteristics of the given LVDT</li><li>3. Measurement of temperature-voltage characteristics of J-type thermocouple</li><li>4. Use a strain gauge to plot the curve between strain applied to a beam and the output voltage</li><li>5. Study of resistance-voltage characteristics of Thermistors</li><li>6. To study on the interface of PLC with PC for data acquisition applications.</li></ol>			

<b>PCEC7310</b>	<b>Microwave Engineering Laboratory</b>	<b>0-0-3</b>	<b>Credits 2</b>
<p><b>LIST OF EXPERIMENTS:</b></p> <ol style="list-style-type: none"> <li>1. Study of Microwave Components and Devices.</li> <li>2. Measurement of klystron characteristics like Electronic Tuning Range, Mode Curves, Carrier Wave Operation, Square Wave Operation.</li> <li>3. Measurement of Frequency and Wavelength in a rectangular waveguide working on TE<sub>10</sub> mode.</li> <li>4. Measurement of VSWR and Reflection coefficient by standing wave method.</li> <li>5. Measurement of Dielectric constants.</li> <li>6. Measurement of Directivity and coupling coefficient of a directional coupler.</li> <li>7. Measurement of attenuation of Fixed and Variable attenuator.</li> <li>8. Study of power division in E-plane and H-plane TEE.</li> <li>9. Determination of the radiation characteristics and gain of horn antenna.</li> <li>10. Determination of the phase-shift of a phase shifter.</li> <li>11. Determination of the standing wave pattern on a transmission line and finding the length and position of the short circuited stub.</li> </ol>			

<b>PJEC8301</b>	<b>Skill Project</b>	<b>0-0-3</b>	<b>Credits 2</b>
<p><b>LIST OF EXPERIMENTS:</b></p> <p style="text-align: center;">(Any three)</p> <ol style="list-style-type: none"> <li>1. Build a smart IoT device to control all the home appliances using an Android App.</li> <li>2. Build a Robot that can follow a line, follow/avoid an obstacle autonomously.</li> <li>3. Finding out the price of a house based on different available features using linear regression.</li> <li>4. Grouping of customers by a telephone company using various classification techniques.</li> <li>5. Build a smart irrigation system using Raspberry Pi.</li> <li>6. Understand Android development concepts and develop different Apps.</li> <li>7. Develop ladder logic to develop MUX and De- MUX.</li> <li>8. Implementation of counter in PLC programming.</li> </ol>			

HSHM3305	Business Communication & Interview Skills	0-0-3	Credit-1
<p><b>COURSE OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To develop communicative competence in prospective engineers.</li> <li>2. To train them to participate in Group Discussion, presentation &amp; face interview</li> <li>3. To understand team dynamic &amp; effectiveness.</li> <li>4. To learn leadership qualities and practice them.</li> <li>5. To develop basic personality traits.</li> </ol> <p><b>Detailed Syllabus</b>  <b>Emphasis will have to be given to practice sessions in the class room by the learners</b></p> <p><b>Module –I (08 Hours)</b></p> <ol style="list-style-type: none"> <li>1. Soft Skills: An introduction-Definition and Significance of Soft Skills; Importance and Measurement of Soft Skill Development, Role of effective communication in professional life.</li> <li>2. Self-Discovery: Discovering the Self; Beliefs, Values, Attitude, Virtue,</li> <li>3. Being Creative: Out of the box thinking, Lateral Thinking and its use.</li> </ol> <p><b>Module-II (12 hours)</b></p> <ol style="list-style-type: none"> <li>1. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.</li> <li>2. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; being a team player, Concept of Leadership and developing Leadership skills</li> <li>3. Group Discussion: Importance, Planning, Elements and Skills. GD as part of a selection process: Evaluation and Analysis</li> </ol> <p><b>Module-III (12 hours)</b></p> <ol style="list-style-type: none"> <li>1. Interview Skills: Interviewee-in-depth perspectives, Types of Interview- In Campus / Onsite/ Telephonic, Before, During and After the Interview. Tips for Success.</li> <li>2. Presentation Skills: Types, Content, Audience Analysis, Essential Tips-Before, During and After, Overcoming Nervousness/ reducing stage fright, visualization strategies, on camera techniques.</li> <li>3. Preparing Curriculum Vitae, Resume, Bio-data, Job Application</li> </ol> <p><b>Module-IV (08 hours)</b></p> <ol style="list-style-type: none"> <li>1. Stress/ Time Management: Definition, Nature, types, Symptoms and Causes; Stress Analysis Models and Impact of Stress; Measurement and Management of Stress. Effective utilization of Time as a resource, Managing Time</li> <li>2. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Types of Leadership behavior; Assertiveness Skills.</li> <li>3. Emotional Intelligence: Meaning, Features, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.</li> </ol>			

**Reference Books:**

1. Managing Soft Skills for Personality Development-edited by B.N. Ghosh, McGraw Hill India, 2012.
2. English and Soft Skills-S.P. Dhanavel, Orient Blackswan India, 2012.
3. Personality Development and Soft Skills by Barun Mitra OUP
4. Communication Skills second edition Kumar Lata OUP
5. Crash Course in Personal Development- Brian Clegg Kogan Page Publication
6. Lateral Thinking by Edward De Bono Penguin Books

**COURSE OUTCOMES**

By the end of course, students shall be able to:

1. Understand the significance and essence of a wide range of soft skills. Learn how to apply soft skills in a wide range of routine social and professional settings.
2. Learn how to employ soft skills to improve interpersonal relationships. Learn how to use soft skills to enhance employability and ensure workplace and career success.
3. Participate in different types of Group Discussions/ Activities effectively, presenting a topic and face interviews with confidence.

**OPEN ELECTIVE-III (OE-III) 6<sup>th</sup> Semester**

<b>OECH6318</b>	<b>Food Biotechnology</b>	<b>3L-0T-0P</b>	<b>3 Credits</b>
<b>Objective of the course:</b> To study the aspects of production, composition and design of food products.			
<p><b>Module-I</b> (12 Hours/4 Weeks)</p> <p><b>Unit – 1 (6 Hours/2 Weeks)</b> Food quality and Production technology: Analysis of food, major ingredients present in different product, Food additives: colour, flavour, vitamins, Single cell protein, mushroom.</p> <p><b>Unit – 2 (6 Hours/2 Weeks)</b> Fermentative production of food, Pickling and alcoholic beverages, genetically manipulated crops-based food, oriental foods, probiotics and prebiotics in food products.</p> <p><b>Module-II</b> (12 Hours/4 Weeks)</p> <p><b>Unit – 3 (6 Hours/2 Weeks)</b> Technology for improved process: Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production.</p> <p><b>Unit – 4 (6 Hours/2 Weeks)</b> Utilization of food waste for production of value-added products, enzymes in sugar syrup, genetically modified food.</p> <p><b>Module-III</b> (12 Hours/4 Weeks)</p> <p><b>Unit – 5 (6 Hours/2 Weeks)</b> Food spoilage and control: Spoilage of food, Microbiology of water, meat, milk, vegetables, microbial safety of food products.</p> <p><b>Unit – 6 (6 Hours/2 Weeks)</b> Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation.</p> <p><b>Module-IV</b> (6 Hours/2 Weeks)</p> <p><b>Unit – 7(6 Hours/2 Weeks)</b> Canning, dehydration, ultrafiltration, sterilization, irradiation.</p> <p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. Modern Food Microbiology, 7th ed. by J M Jay, M J Loessner, and DA Golden, Springer.</li> <li>2. Food Microbiology, 5th ed. by W C Frazier and D C Westhoff, McGraw-Hill.</li> <li>3. Prescott &amp; Dunn's Industrial Microbiology by G Reed, CBS.</li> <li>4. Technology of Food Preservation, 4th ed. by N W Desrosier and J N Desrosier, Avi Publishing Co Inc.</li> <li>5. Introduction to Food Engineering, 5th ed. by R P Singh and D R Heldman, Academic Press.</li> </ol>			
<p><b>Course Outcomes:</b></p> <p>At the end of the course, the student should be able to</p> <ol style="list-style-type: none"> <li>1. Understand the process used to enhance the production, nutritional value, safety and taste of food.</li> <li>2. Know about the modern biotechnological techniques applied to food science.</li> </ol>			

3. Know about improving crops so that they need fewer pesticides.
4. Design product & functionality, understand food innovation and marketing.
5. Gain knowledge about the rapid detection techniques of foodborne pathogens and chemical senses.
6. Know about the requirements for careers in the dynamic food sector as well as for research and development.

<b>OECH6319</b>	<b>Fluidization Engineering</b>	<b>3L-0T-0P</b>	<b>3 Credits</b>
<p><b>Course objectives:</b> The objectives of this course are to introduce</p> <ol style="list-style-type: none"> <li>1. Basics of fluidization and various industrial application of fluidization;</li> <li>2. Various fluidization regime, classification of particles;</li> <li>3. Describe the staging of fluidized bed reactor.</li> </ol>			
<p><b>Module-1</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Basics of fluidization, types, behaviour, and parameters</b>  <b>Unit I (6 Hours/2 weeks):</b> Introduction to fluidization, types of fluidization, gross behavior of fluidized beds, minimum fluidization velocity.</p> <p><b>Unit II (6 Hours/2 weeks):</b> Pressure drops in fluidized beds, bed voidage, transport disengaging height, viscosity and fluidity of beds, bubble behavior, bed expansion, distributor design.</p> <p><b>Module-2</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Mathematical treatment and calculations</b>  <b>Unit III (6 Hours/2 weeks):</b> Simple mathematical treatment, Solid transport: flow and fluidized solids, solids transfer, terminal velocity, particle entrainment and elutriation.</p> <p><b>Unit IV (6 Hours/2 weeks):</b> Simple calculations relating to solid transport.</p>			
<p><b>Module-3</b> <span style="float: right;"><b>(4 weeks/12 Hours)</b></span>  <b>Heat and mass transfer in fluidized beds</b>  <b>Unit V (6 Hours/2 weeks):</b> Heat and mass transfer in fluidized beds: Heat transfer mechanism, principles of gas-solid and bed surface transfer, heat transfer to liquid fluidized systems.</p> <p><b>Unit VI (6 Hours/2 weeks):</b> Generalized correlation for fluidized bed mass transfer and its limitations.</p>			
<p><b>Module-4</b> <span style="float: right;"><b>(2 weeks/6 Hours)</b></span>  <b>Semi-fluidization and fluidized bed reactors</b>  <b>Unit VII (6 Hours/2 weeks):</b> Semi-fluidization: principles, estimation of various bed parameters, Industrial applications; Design of fluidized bed reactors: Concept of RTD, basic design principles for fluidized bed.</p>			

**Text books :**

1. 'Fluidization Engineering', 2nd ed. by D Kunii and O Levenspiel, Butterworth Heinemann.

**Reference Books :**

1. 'Fluidization' by M Leva, McGraw-Hill.
2. 'Fluidization' by J F Davidson and D Harrison, Academic Press.

**Course Outcomes (CO):**

At the end of the course, students would be able to understand about

1. Concept of fluidization
2. Applications of fluidization
3. Semi-fluidization
4. Fluidized bed reactors

<b>OECE6320</b>	<b>Structural Dynamics and Earthquake Engineering</b>	<b>(3-0-0)</b>	<b>Credit-03</b>
-----------------	---	----------------	------------------

**Module I**

Elements of Earthquake origin & Propagation: Elements of Seismology, Earthquakes, Structure of the Earth, History of the Earth, Earthquake Mechanism, Propagation of Seismic Waves, Earthquake Phenomena, Earthquake Measurements, Definitions of magnitude, intensity, epicentre etc; Plate tectonics, seismographs, liquefaction, Types, effects and controlling factors

**Module II**

Theory of Vibration Effects: Dynamic Loads. D'Alembert's Principle and inertia forces, Stiffness and flexibility of elastic structures, Theory of Vibrations, Free vibrations of single and multiple degree freedom systems, computations of dynamic response to time dependent forces, mass and stiffness matrices, natural frequencies, Plate Tectonics Theory.

**Module III**

Earthquake Resistant Design: Principles of Earthquake Resistant Design, Response spectrum theory. Time – Acceleration method, Application of response spectrum theory to seismic design of structures.

**Module IV**

Earthquake Damages: Earthquake Damages to Various Civil Engineering Structures, Case Histories Earthquake, Earthquake response of structures, Soft storey collapse, Slender structures, unsymmetrical structures. Methods of disaster prevention: Earthquake resistant building Regulations, specification, guidelines for construction – Materials selection.

**Reference Books**

1. A K. Chopra (2003), Dynamics of Structures-Theory and Applications to Earthquake Engineering,

Second Edition, Prentice-Hall India Pvt Ltd.

2. Pauley & Priestly (1995), Seismic design of reinforced concrete and masonry buildings, John Wiley & Sons.
3. Stratta. J.L. (2000), Manual of Seismic Design, Prentice-Hall India Pvt Ltd.
4. Kramer. S.L. (2000), Geotechnical Earthquake Engineering, Prentice-Hall India Pvt Ltd.
5. Agarwal & Shrinkhardo (2006), Earthquake Resistant design of structures, Prentice-Hall India.

OECS6321	Data Science	3-0-0	Credit-03
<p><b>Prerequisite:</b> Brief knowledge in programming in C, C++ with great interest in quantitative/statistical analysis and a student having degree in BTech in any branch of Engineering, MCA, M.Tech, MS having occasionally programming knowledge may enrol for this subject. As this is just an introductory to data science techniques even a simple graduate student may take this course.</p> <p><b>Module I:</b> <span style="float: right;"><b>10 Hrs.</b></span> Benefits and uses of data science and big data, Data Science steps, Facets of data, Structured data, Unstructured data, Natural language , Machine-generated data, Graph-based or network data, Audio, image, and video, Streaming data, The data science process, Setting the research goal, Retrieving data, Data preparation, Data exploration, Data modelling or model building, Presentation and automation, The big data ecosystem and data science, Distributed file systems, Distributed programming framework, Data integration framework, Python Environment set-up, Jupyter overview, Python Numpy, Python Pandas, Python Matplotlib.</p> <p><b>Module II:</b> <span style="float: right;"><b>8 Hrs.</b></span> An introduction to R, Data structures in R, Data visualization with R, Data analysis with R, Data science using MS-excel, Important statistical concepts used in data science, Difference between population and sample, Types of variables, Measures of central tendency, Measures of variability, Coefficient of variance, Skewness and Kurtosis, Normal distribution, Test hypotheses, Central limit theorem, Confidence interval, F-test, T-test, Chi-square test, Type I and II errors, Student's T distribution.</p> <p><b>Module III:</b> <span style="float: right;"><b>10 Hrs.</b></span> Regression, ANOVA, R square, Correlation and causation, Exploratory data analysis, Data visualization, Missing value analysis, The correction matrix, Outlier detection analysis, Supervised machine learning, Python Scikit tool, Neural networks, Support vector machine, Logistic and linear regression, Decision tree classifier, Tableau, Working with Tableau, Deep diving with data and connection, Creating charts, Mapping data in Tableau, Dashboards and stories.</p> <p><b>Module IV:</b> <span style="float: right;"><b>10 Hrs.</b></span> Machine learning on cloud, ML on cloud platform, ML on AWS, ML on Microsoft Azure, Understanding NoSQL databases and why they're used today, Identifying the differences between NoSQL and relational</p>			

databases, Defining the ACID principle and how it relates to the NoSQL BASE principle, Learning why the CAP theorem is important for multi-node database setup, Applying the data science process to a project with the NoSQL database Elastic search, The rise of graph data bases, graph mining, test mining and analysis, Natural Language Toolkit(NLTK),Data visualization to the end user, Dashboard development tools.

### Text Books:

There is no text book for the course. A teacher may use lecture notes and videos, read research papers and Web Pages, which will be freely available on internet websites.

### Reference Books:

1. Introducing Data Science BIG DATA, MACHINE LEARNING, AND MORE, USING PYTHON TOOLS by DAVY CIELEN ARNO, D. B. MEYSMAN and MOHAMED ALI, MANNING SHELTER ISLAND
2. Introduction to Probability – By Joseph K. Blitzstein and Jessica Hwang
3. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data 1st Edition, by Hadley Wickham
4. Python Data Science Handbook, Jake Vander Plas, *O'reilly*
5. Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, Aurélien Géron (Author),O'reilly

OEEE6322	Sensors and Transducers	3-0-0	3 Credits
<p><b>Module -I</b> <span style="float: right;"><b>[12 Hours]</b></span></p> <p>Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. <b>(Bentley: Chapters 1-4)</b></p> <p>Techniques for dynamic compensation, Loading Effects and Two-port Networks <b>(Bentley: Sections 4.4 and 5.1-5.2)</b></p> <p><b>Module-II</b> <span style="float: right;"><b>[12 Hours]</b></span></p> <p>Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric;</p> <p>Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors. <b>(Bentley: Sections 8.1 to 8.6)</b></p>			

RVDT, Hall Effect sensors (**Bentley: Sections 8.3 and 8.10**)

Piezoelectric sensing elements, Piezo-resistive sensing elements.

(**Bentley: Sections 8.7 and 8.8**)

### Module-III

[12 Hours]

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity.

Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation

(**Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2**)

Current transmitters, Oscillators and resonators (**Bentley: Sections 9.4 and 9.5**)

### Module-IV

[6 Hours]

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.

IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

(**Ghosh: Section 10.3 to 10.4**)

### Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.

### Reference Books:

1. Measurement Systems Application and Design- E.O. Doebelin (4/e), McGraw-Hill, International, NY.
2. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

<b>OEEC6324</b>	<b>Mechatronics</b>	<b>3-0-0</b>	<b>Credits 3</b>
-----------------	---------------------	--------------	------------------

### COURSE OBJECTIVES

1. Understand key elements of Mechatronics system, its block diagram representation.
2. Understand principles of sensors, transducers, encoders and actuators and its characteristics.

3. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial applications.
4. Understand the system modelling and analysis in time domain and frequency domain.

**MODULE-I****(12 Hours)****Unit 1**

**Fundamental of Mechatronics:** Definition and concepts of Mechatronics, Conventional system vs. mechatronic system, Evolution of Mechatronics.

**Unit 2**

Hardware components for Mechatronics. Need and Role of Mechatronics in Design, Manufacturing and Factory Automation.

**MODULE-II****(12 Hours)****Unit 3****Sensors:**

An introduction to sensors. Principle of operation, Difference between transducer and sensors. Sensor types- Transducer signal conditioning sensor, velocity and motion sensor, force sensor, fluid pressure sensor, liquid flow sensor, liquid level sensor, temperature sensor.

**Unit 4****Transducers:**

Introduction to transducers. Transducer types – photo emissive transducer, photo conductive transducer, photovoltaic transducer, thermistors, thermocouple, inductive transducer, capacitive transducer, piezoelectric transducer, hall effect transducers, ionization transducer, Use of sensor and transducer for specific purpose in mechatronics.

**MODULE-III****(12 Hours)****Unit 5****Actuators and encoders:**

Electric motors: D.C. Motors, Stepper motor. Hydraulic actuators, Pneumatic actuators. Principle of operation of encoders, Types of encoders- incremental encoder, optical encoder, bimetallic strip encoder, strain gauge encoder, load cell encoder.

**Unit 6****Programmable Logic Controller:**

Basic Structure- Programming: Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling, Analog input / output , PLC Selection & Application.

**MODULE-IV****(8 Hours)****Unit 7**

**MEMS and Microsystems:**

Overview of MEMS and Microsystems. Micromachining techniques: silicon as a material for micromachining, photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, wafer bonding, packaging.

**Microsystems modelling and Design:**

Mechanics of deformable bodies. Energy method. Estimation of stiffness and damping for different microstructures. Modelling of electromechanical system, it's analysis in time domain and frequency domain, pull-in voltage. Applications of MEMS.

**Text Books:**

1. Mahalik N.P, "Mechatronics: Principles, Concepts and applications", Tata McGraw Hill, 3<sup>rd</sup> edition (Indian), 2012.
2. Appu Kuttan, "Introduction to Mechatronics", Oxford University, 2007.

**Reference Books:**

1. RK Rajput, "A Textbook of Mechatronics", S. Chand Publishing, 1<sup>st</sup> Edition, 2007.
2. Ananthasuresh & Gopalkrishnan, "Micro and Smart Systems", Wiley India, 2012
3. A. Smaili & F Mrad, "Applied Mechatronics", Oxford University Press, 1<sup>st</sup> Edition 2007.
4. S. D. Senturia, "Microsystem Design", Springer, 1<sup>st</sup> edition 2<sup>nd</sup> reprint 2004

**Course Outcomes:**

1. To model, analyze, and control engineering systems.
2. Identify sensors, transducers, and actuators to monitor and control the behaviour of a process or product.
3. Develop PLC programs for a given task.
4. Evaluate the performance of mechatronics systems.

<b>OEHM6325</b>	<b>MARKETING MANAGEMENT</b>	<b>3-0-0</b>	<b>Credit-3</b>
-----------------	-----------------------------	--------------	-----------------

**Course Objectives**

1. To understand the concepts of marketing management
2. To learn about marketing process for different types of products and services
3. To understand the tools used by marketing managers in decision situations
4. To understand the marketing environment

**Course Content****UNIT 1: Basic Concepts of Marketing**

Definition, Concept of Exchange-Needs & Wants, Marketing Concept, Process, Marketing environment, Elements of macro and micro environment, Competition analysis, Factors contributing to competition, Porters five forces model, identifying and analyzing competitors, Marketing planning process, Market research and information system, Research process, consumer behavior, factors influencing consumer behavior.

**UNIT 2: Market segmentation, targeting and positioning**

Definition, Bases of segmenting consumer and industrial market, Target market strategies, Market positioning, Market demand forecasting :forecasting tools, short term tools, Moving average and exponential smoothing methods, Long term forecasting tools- time series analysis, Econometric method, Qualitative methods– Buying intention survey, sales force opinion, Delphi techniques, Product planning- Product planning and new product planning process.

**UNIT 3: Price decision**

Objectives and factors influencing price, Pricing methods and strategies, Integrated marketing communication (IMC), Concept of IMC, The marketing communication process, Promotion mix, Elements of promotion mix, Channel of distribution: types of intermediaries, functions of distribution channels, channel levels, physical distribution, supply chain management (basic only)

**Text Books**

1. Kotler, P., Keller, K. L., Koshy, A., & Jha, M. (2012), Marketing Management A South Asian Perspective, 14th Edition, Pearson Education, New Delhi.
2. Ramaswamy, V. S., & Namakumari, S. (2017), Marketing Management: Indian Context with Global Perspective, McGraw hill.

**Reference Books**

1. Kotler, Philip. Marketing Management, Millennium Edition. Intl ed. US: Prentice Hall, 2002. ISBN: 8120316096.
2. Principles of Marketing, Kotler and Armstrong, Pearson, 12th edition., 2008, ISBN: 978-81- 317-1547-5

**Course Outcomes**

On completion of this course, the students will be able to:

- CO 1. Demonstrate strong conceptual knowledge in the functional area of marketing management.
- CO 2. Demonstrate effective understanding of relevant functional areas of marketing management and its application.
- CO 3. Demonstrate analytical skills in identification and resolution of problems pertaining to marketing management

OEMA6326	Optimization in Engineering	3-0-0	Credit-3
<p><b>Module-I. (12 Hours)</b>            Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling. Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.</p> <p><b>Module-II. (12 Hours)</b>            Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment Problems Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems.</p> <p><b>Module-III. (13 Hours)</b>            Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.</p> <p><b>Module-IV. (8 Hours)</b>            Queuing models: General characteristics, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline. Introduction to Genetic Algorithm.</p> <p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. A. Ravindran, D. T. Philips, J. Solberg, Operations Research- Principle and Practice, Second edition, Wiley India Pvt. Ltd.</li> <li>2. Prabhakar Pai, Operation Research, Oxford University Press.</li> <li>3. H.A. Taha, A.M. Natarajan, P. Balasubramanie, A. Tamilarasi Operations Research, Pearson Education, Eighth Edition.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Stephen G. Nash, A. Sofer Linear and Non-linear Optimization, McGraw Hill, 2<sup>nd</sup> Edition.</li> <li>2. A. Ravindran, K.M. Ragsdell, G.V. Reklaitis, Engineering Optimization, Wiley India Pvt. Ltd, Second edition.</li> <li>3. F.S. Hiller, G.J. Lieberman, Operations Research, Tata McGraw Hill, Eighth Edition. .</li> </ol>			

OEME6327	Industrial Engineering and Operation Research	3-0-0	Credit-3
<p><b>Product Design and Development:</b> Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives.</p> <p><b>Work System Design:</b> Taylor’s scientific management, Gilbreths’s contributions; productivity – concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.</p> <p><b>Facility Design:</b> Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems.</p> <p><b>Operation Research:</b> Linear programming – problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; Markovian queuing models; dynamic programming; simulation – manufacturing applications. Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource levelling. Production control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; routing, scheduling and priority dispatching; Push and pull production systems, concept of JIT manufacturing system; Logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic inventory models, quantity discount; perpetual and periodic inventory control systems.</p> <p><b>Project management – PERT and CPM.</b></p> <p><b>Text Book:</b></p> <ol style="list-style-type: none"> <li>1. Production &amp; operations management, K. Aswathappa, K.S. Bhat, Himalaya Publishing House, edition 2012.</li> <li>2. R. Paneerselvam, Production operations Management</li> <li>3. Operations Research, D.S.Hira, Gupta, S Chand Publisher</li> <li>4. Industrial Engineering &amp; Management, O P Khanna, Dhanpat Rai &amp; Sons</li> <li>5. WORK STUDY &amp; TIME STUDY,ILO</li> </ol>			

<b>OEMT6328</b>	<b>Biomaterials</b>	<b>3-0-0</b>	<b>Credits 3</b>
<p><b>Objectives of the Course:</b></p> <ol style="list-style-type: none"> <li>1. To introduce the student to the range of biomaterials and the science and engineering of biomaterials.</li> <li>2. To understand constraints associated with the use of biomaterials</li> </ol> <p><b>Module 1: (12 Hours)</b> Introduction to basic concepts of Materials Science, Salient properties of important material classes Property requirement of biomaterials, Concept of biocompatibility, Structure and properties of biological cells &amp; tissues, Cell fate processes (cell migration, cell differentiation, cell apoptosis, cell division), Cell signaling processes, Cell-material interactions and foreign body response</p> <p><b>Module 2: (12 Hours)</b> Bone tissue–structure, bone tissue-property, assessment of biocompatibility of biomaterials, in vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation- ALP assay; Biomineralisation - Osteocalcin assay), In vivo testing and histocompatibility assessment, Genotoxicity assessment,</p> <p><b>Module 3: (12 Hours)</b> Important biometallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys Bioinert, Bioactive and Bioresorbable ceramics, Processing and properties of different hydroxyapatite (HA)-based biocomposites, Synthesis of biocompatible coatings on structural implant materials, Fabrication of porous scaffold materials using electrospinning and 3D printing, Microstructure and properties of glass-ceramics; biodegradable polymers, Processing and Properties of some Polymer-based Biocomposites,</p> <p><b>Module 4: (06 Hours)</b> Design concept of developing new materials for bio-implant applications</p> <p><b>Suggested Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Introduction to Biomaterials: Basic Theory with Engineering Applications; C.L Agrawal, J.L. Ong, Mark R Appleford, Gopinath Mani, Cambridge University Press, 2013</li> </ol> <p><b>Suggested Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Biological Performance of Materials: Fundamentals of Biocompatibility (Third Edition, Revised and Expanded); Author: Jonathan Black; Publisher - Marcel Dekker, 1999</li> <li>2. Biomaterials Science and Biocompatibility; Authors: Frederick H. Silver and David L. Christiansen; Publisher: Springer-Verlag New York, 1999</li> <li>3. Biomaterials Science: An Introduction to Materials in Medicine; Editors: Buddy D. Ratner, Allan S. Hoffman, Fredrick J. Schoen and Jack E. Lemons; Publisher: Elsevier Inc., 2004</li> <li>4. Molecular Biology of the Cell; Fourth edition; Authors: Bruce Alberts, Alexander Johnson, Julian Lewis, Keith Roberts and Peter Walter; Publisher: Taylor &amp; Francis, New York, 2002</li> </ol>			

5. B. Basu, D. Katti and Ashok Kumar; Advanced Biomaterials: Fundamentals, Processing and Applications; John Wiley & Sons, Inc., USA, September, 2009.

**Course Outcomes:**

After completing the course, the student will be able to:

1. Explain the types of Biomaterials and their relative advantages and disadvantages
2. Indicate the constraints placed on the use of materials in biological environments
3. Explain the characterization of materials from the perspective of application as a
4. Biomaterial

OEPD6329	OPERATION RESEARCH	3L-0T-0P	3 Credits
<p><b>Course Objective</b> Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively; knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry; skills in the use of Operations Research approaches and computer tools in solving real problems in industry; Mathematical models for analysis of real problems in Operations Research. Identify and develop operational research models from the verbal description of the real system.</p> <p><b>Module I</b> <span style="float: right;"><b>[12]</b></span> <b>Introduction:</b> Definition, Characteristics and phases, Applications of OR. Linear Programming: Problem Formulation, Graphical solution, Simplex method - Artificial variables technique (i.e. Big M method only) - Duality principle, simple problems on dual formulation only, sensitivity analysis.</p> <p><b>Module II</b> <span style="float: right;"><b>[10]</b></span> <b>Transportation Model:</b> Formulation, IBFS-North West Corner method, LCEM, VAM, Unbalanced transportation problem, Optimality test by MODI method. <b>Assignment Model</b> - Formulation - Optimal solution by Hungarian method – Unbalanced Assignment problem- Restricted case.</p> <p><b>Module III</b> <span style="float: right;"><b>[10]</b></span> <b>Queuing Models:</b> Introduction – Kendall’s Lee notation- single channel with infinite population, Multichannel with infinite population <b>Networking Model:</b> PERT, CPM</p> <p><b>Module IV</b> <span style="float: right;"><b>[08]</b></span> <b>Theory of Games:</b> Introduction-classification of games- 2 person zero sum games- Assumptions -solution of games with saddle points - Rectangular games without saddle points, dominance principle - 2 X 2 games by</p>			

Algebraic method,  $m \times 2$  &  $2 \times n$  games by graphical method.

**Text Books:**

1. Operation Research by Panarsalvam
2. Operation Research by Kalavathy

**Reference Books:**

1. Hiller & Libermann, "Introduction to Operations Research", 8th ed., Tata McGraw Hill, 2010.
2. D.S. Hira and R.K. Gupta, "Operations Research", 5th ed., S.Chand & Co., 2008.
3. Taha, "Introduction to Operations Research." 8th ed., PHI Publications, 2008.
4. S.D. Sharma, "Operations Research", 8th ed., Kedarnath Publishers, 2007.

**Course Outcomes:**

Upon successful completion of the course, student will able to:

1. Recognize the importance and value of Operations Research and mathematical modelling in solving practical problems in industry.
2. Formulate a managerial decision problem into a mathematical model;
3. Understand Operations Research models and apply them to real-life problems;
4. Use computer tools to solve a mathematical model for a practical problem.
5. Cognitive skills (thinking and analysis)
6. Be able to build and solve Transportation Models and Assignment Models.
7. Be able to understand the characteristics of different types of decision.